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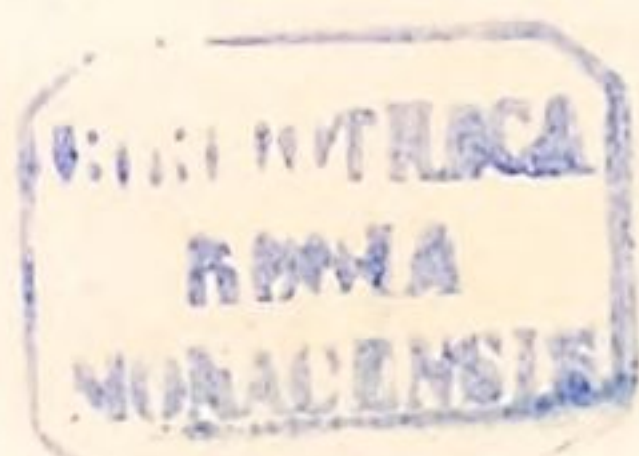
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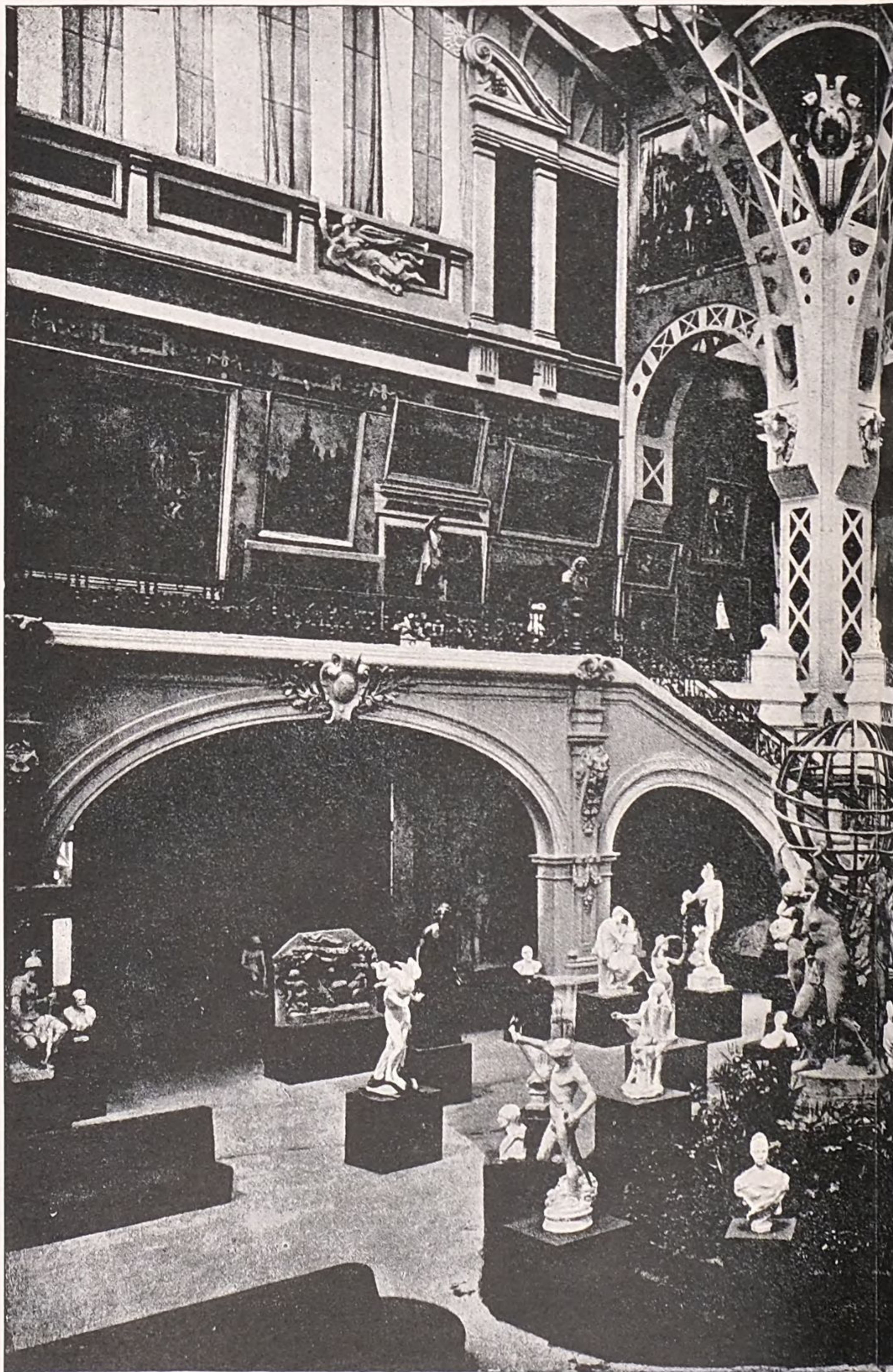
FIRST SESSION OF THE FIFTY-FIRST CONGRESS.

1889-'90.

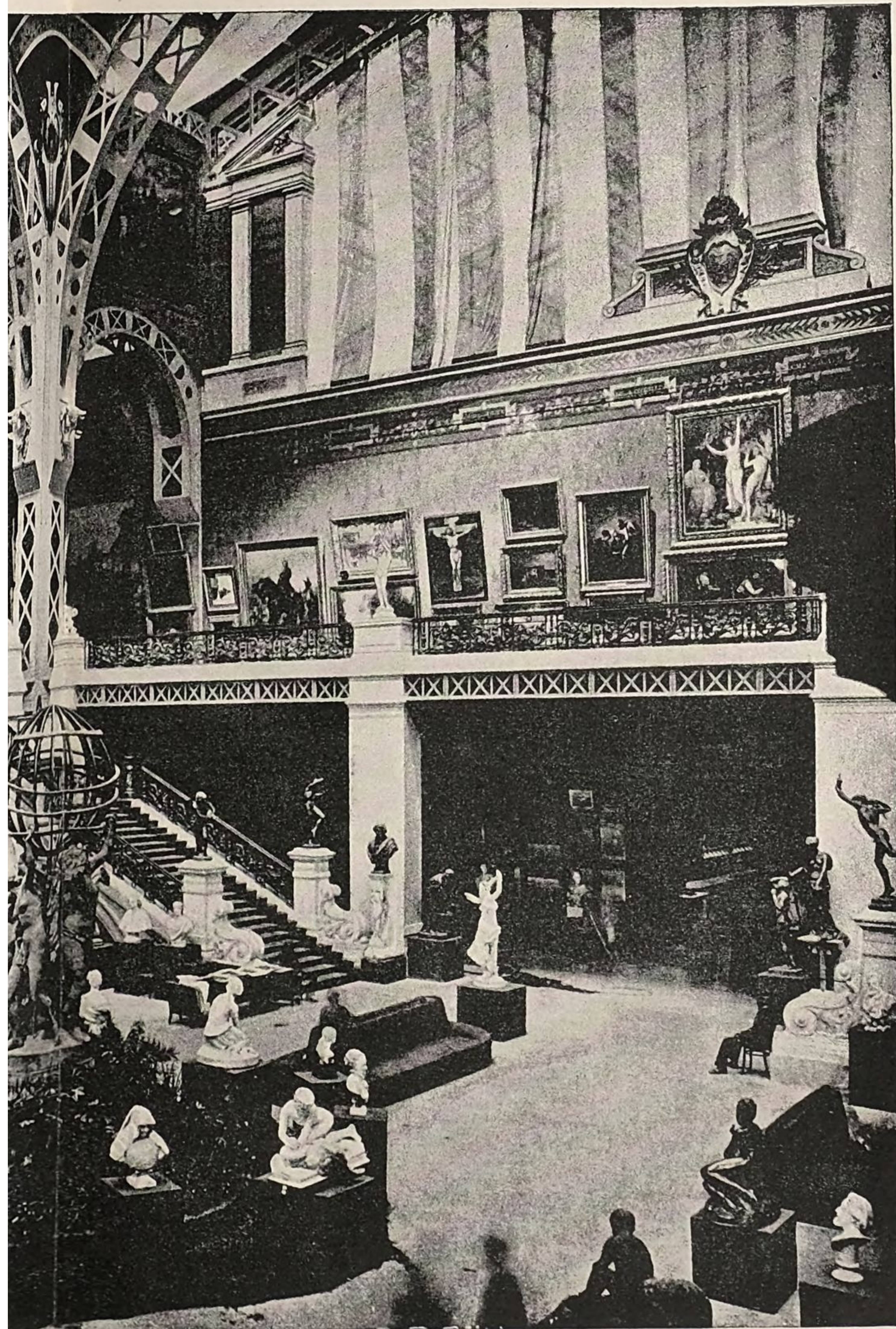
VOLUME 39.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1893.





UNDER THE DOME OF THE P



THE PALACE OF FINE ARTS.

(Frontispiece.)

51ST CONGRESS, } HOUSE OF REPRESENTATIVES. { Ex. Doc. 410,
1st Session. } Part 2.

REPORTS

OF THE

UNITED STATES COMMISSIONERS

TO THE

UNIVERSAL EXPOSITION OF 1889

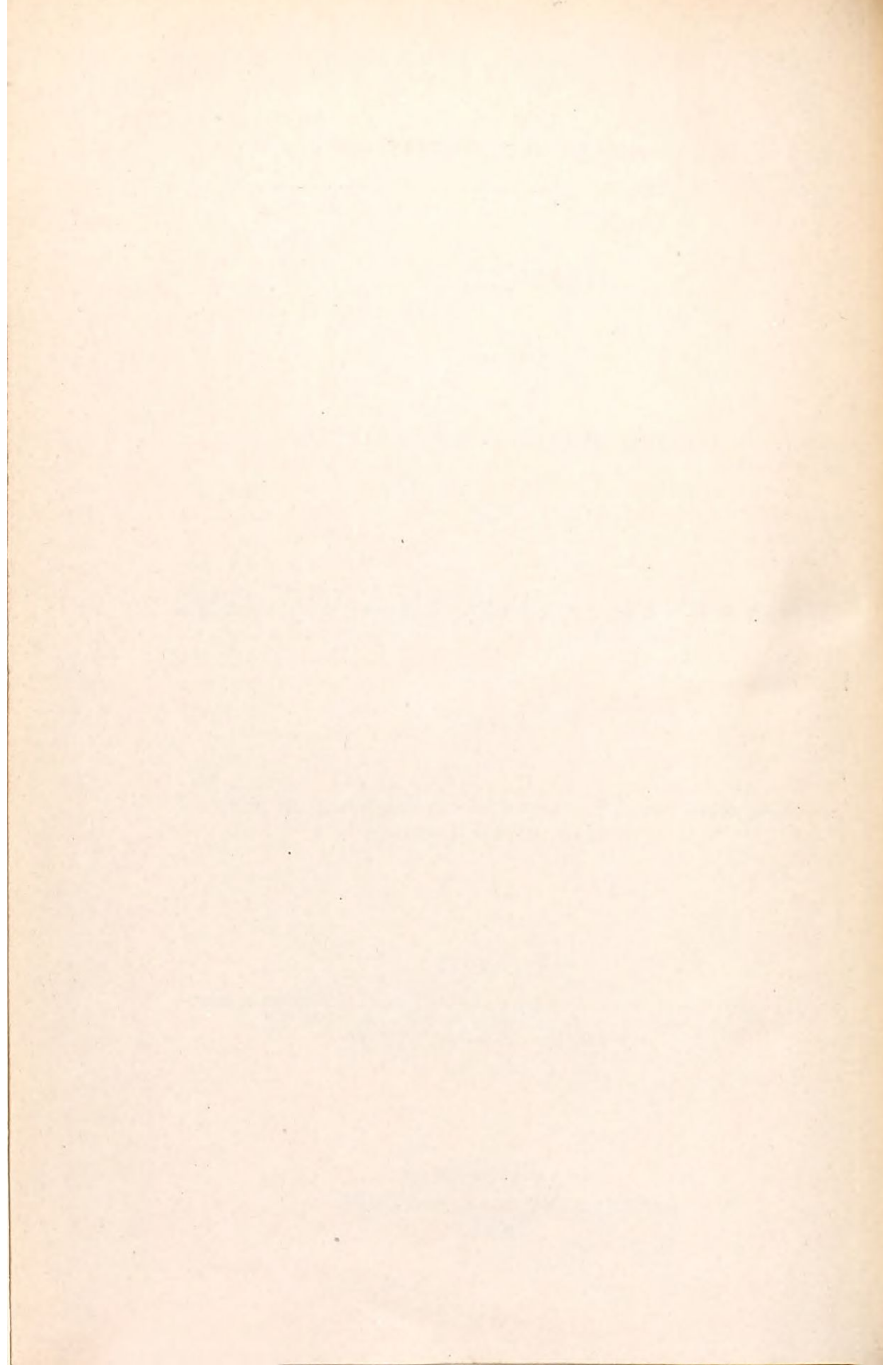
AT PARIS.

PUBLISHED UNDER DIRECTION OF THE SECRETARY OF STATE
BY AUTHORITY OF CONGRESS.

VOLUME II.

FINE ARTS; EDUCATION AND LIBERAL ARTS; FURNITURE; TEXTILE FABRICS
AND WEARING APPAREL; EXTRACTIVE ARTS, RAW AND
MANUFACTURED PRODUCTS; HYGIENE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1891.



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FIRST GROUP.

WORKS OF ART.

(EXTRACT FROM THE OFFICIAL CLASSIFICATION.)

FIRST GROUP.

WORKS OF ART.

- CLASS 1. Oil paintings: Paintings on canvas, panels and various grounds.
- CLASS 2. Paintings of different kinds, and drawings: Miniatures; paintings in water colors; pastel and drawings of all kinds; paintings on enamel, earthenware, and porcelain; cartoons for stained glass windows and frescoes.
- CLASS 3. Sculpture and engravings on medals: Statuary, bas-relief, repoussé work, and chiseled work; medals, cameos, engraved stones; inlaid enamel work.
- CLASS 4. Architectural drawings and models: Studies and fragments; representations and plans of buildings; restorations from ruins or documents.
- CLASS 5. Engravings and lithographs: Engravings in black; polychromatic engravings; lithographs in black, in chalk, and with brush; chromolithography.

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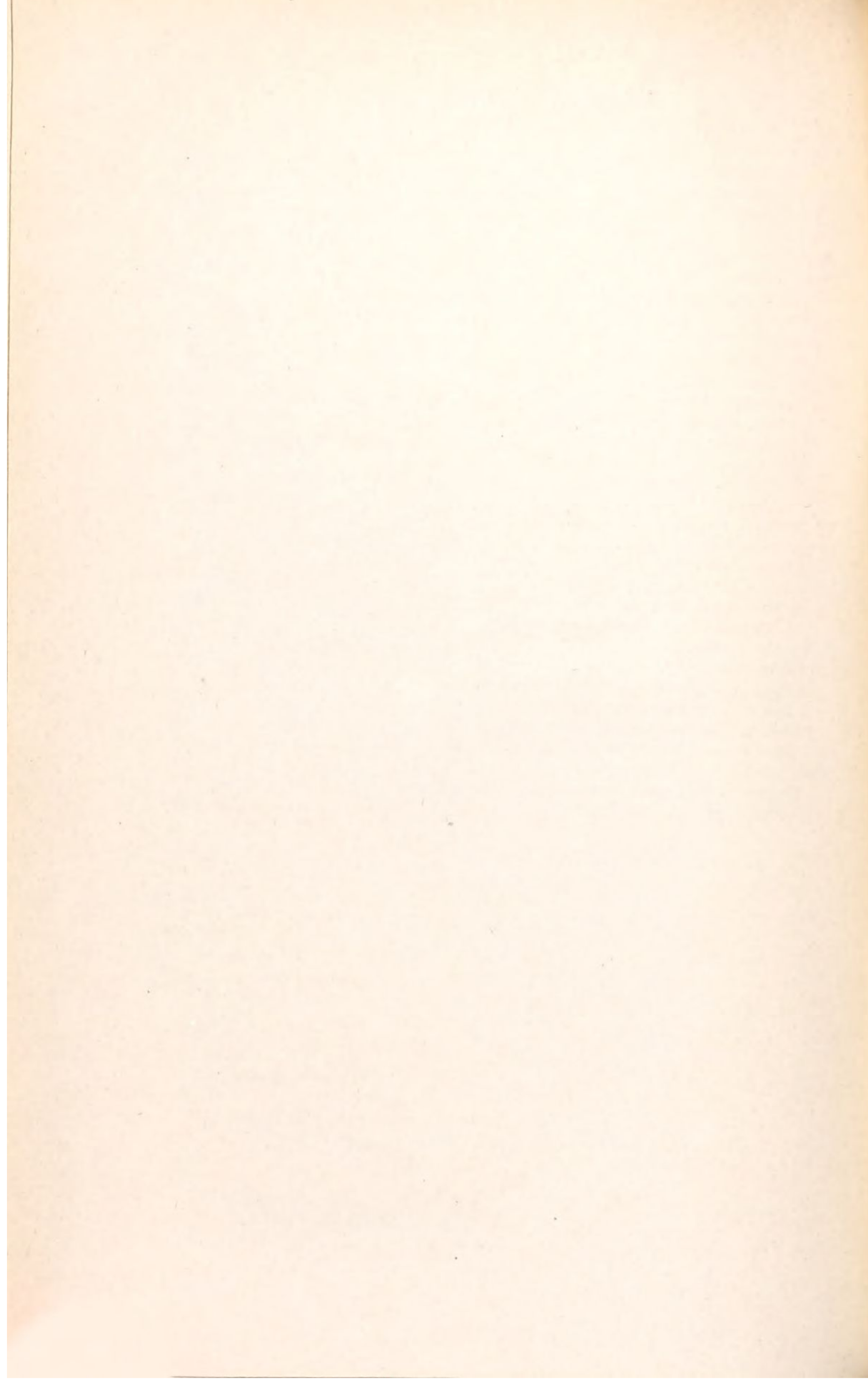
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REPORT ON THE FINE ARTS.

By RUSH C. HAWKINS, Commissioner.

INSTRUCTIONS FROM THE SECRETARY OF STATE.

In a letter of instructions which the writer received from the Secretary of State the following passage occurs :

Your general duty is to make a thorough examination of the articles exhibited in the group of the Exposition to which you are specially assigned, and to report upon the state of such art, science, or industry in the year 1889 as shown in the Exposition. This report will be published by Congress, and is intended for the benefit of the people of the United States. I need not, therefore, impress upon you the necessity of making it thorough and exact, and at the same time of practical benefit to our fellow countrymen.

When the unprecedented magnitude of the display of modern works of art at the Paris International Exhibition of 1889 is taken into consideration, the seriousness of the task imposed becomes bewilderingly apparent. The working portion of the lifetime of the best equipped art writer living, faithfully bestowed, would not be sufficient for the success of such an undertaking.

ADVERSE INFLUENCES.

The value to the people of the United States of a report such as the one required seems to the writer to be open to question. Even if it were prepared by a scholar versed in the arts and equal in capacity to the best living writer upon those subjects, it is doubtful if it would exercise any perceptible influence upon the education of public taste. The crushing power of unprecedented enormous wealth concentrated in the possession of a comparatively small number of our population, and the conceit it engenders in the minds of its possessors, constitutes a sort of intangible Chinese wall, which stands as a barrier against general improvement in matters of taste and artistic adornment. The process of the cultivation of this powerful class to a fair standard of civilization, their conversion from a belief in the meretricious in art to an intelligent appreciation of the lastingly beautiful must at best be of very slow growth.

ART IN THE UNITED STATES.

Unfortunately for the artistic reputation of our country, testimony fully sustaining the truth of this statement is far too abundant, and we need to search in but one or two of our fruitful fields for illustration. Our public statues, groups, and other monuments erected to perpetuate the memory of distinguished men, heroic deeds and great events, and purchased (often at enormous unprecedented expense) as works of art, constitute one of the most discouraging chapters in our national history. Of the many hundreds and possibly thousands of such works which exist on our soil, it is quite safe to assert that there are not more than twenty-five which, from an art standpoint, are fairly good. Prominent in this great aggregation of base ornaments, and perhaps the most offensive because of its great size, is the common place pile erected to President Lincoln at Springfield, Illinois. It is so ostentatiously weak in nearly every respect that instead of its being accepted as an object of interest and veneration, it must be regarded as a curious pile devoid of intended significance or artistic expression. Its astonishing groups of statuary, heroic in size, are bronze monstrosities of unprecedented hideousness.

The Gettysburgh battlefield, the future Mecca of the North American Continent, its sacred soil consecrated to a great cause by the blood of thousands of heroic men, is now in reality a field of perpetual horrors which neither wind, storm, nor time will destroy. Let us hope that the sacred associations surrounding these attempts at appropriate commemorative monuments will in the future prevent the motive being mistaken for one of caricature, and that the lofty desire to justly honor noble deeds which was the primary cause of these violations of good taste, may be accepted as a mitigating excuse for their existence.

The capital of our country presents another field of investigation to those in search of the monstrous in art. From the time of the Mills statue of General Jackson and the erection of the cast iron dome of the Capitol, to the present day, the stream of bad statues and worse architecture has continued to flow in upon a historic soil hallowed by the memories of many decades filled with great events.

WASHINGTON AS AN ART CENTER.

We are compelled to regard Washington as one of the art centers of our country for two sufficient reasons. The first is that it contains more statues and public monuments than any other city in the United States; in the second place, it has within its boundaries a greater number of large and important public buildings than any other American city. In addition to its open-air monuments it possesses a chamber of horrors which contains voluntary contributions in the

form of statues from the several States composing the Union, such as in any of the countries of Western Europe would make the fortune of a second Madame Tussaud. This certainly is the most curious collection of unartistic and possibly semi-grotesque specimens of marble cutting ever assembled under a single roof.

Most of the products of the brush which are supposed to ornament the Capitol, are fully up to the level of the Government statuary. They were born of a period of our history when debased politics, ignorance as to the value of the beautiful, and want of patriotic pride in the æsthetic reputation of a nation, prevented the legitimate and natural growth of a love for the arts.

WASHINGTON ARCHITECTURE.

The majority of the later examples of architecture paid for by the people's money are, as to art value, quite as low down in the scale as the statues. Since the erection of the Patent Office Building there has been a steady deterioration in intelligence of design and sense of the beautiful. Let us hope, however, that in the new Pension Office the downward extreme has been reached, for it certainly does seem that deeper into the depths of the commonplace or of the barn-building style we can not go. The existence of a cast-iron dome resting upon a stone semi-Greek monumental structure, both having to be painted white every year, the new National Museum of no particular order, but bearing a remarkable resemblance to what a large beer-garden might be, and the new pile west of the White House ought to have satisfied the reasonable desire of any government in search of the truly original. But it seemed that their presence only served to whet the appetite of our public officials for more, and in order to satisfy their longing the Pension Office Building had to be raised. Let us console ourselves with the belief that in the existence of this structure we see the culmination of the decadence of architecture in Washington.

BANK NOTES, COINS, AND STAMPS.

There is no excuse for our not having better bank notes, coins, and stamps, which if artistic in design would prove valuable object lessons for improving public taste, but so insensible are Government officials in charge of certain departments to the value of the beautiful in its application to every day life, that it has never occurred to them to give the people an artistic bank note in the place of the detestable "greenback," a silver or composition coin of beauty, or a postage stamp above the level of the lowest commonplace. There can be no reasonable excuse for this neglect. A change for the better is only a matter of small expense and art knowledge enough to enable a Government agent to select artistic designs.

STATUES AND MONUMENTS GENERALLY CONSIDERED.

New York, Boston, Philadelphia, Brooklyn, others of the larger cities, and possibly nearly all of the lesser ones, have erected to national and local notabilities, regiments, companies, or batteries their full share of public monuments. In this race for open-air statues New York has fairly outrun her sister cities, and of her achievements, as of those of Washington, it may be said that the latest are the worse. The first statue raised in New York of any value as a work of art was the equestrian of Washington, by H. K. Brown. It is remarkable for its dignified repose and its simplicity of design, and as a whole fairly represents the greatest American. The latest statue erected in that city is one intended to represent Garibaldi in his historic fighting costume. It is far worse than any of its predecessors, and so thoroughly does it lack intelligible design that we may safely say that in the descending scale from the Washington statue its place is the lowest. Possibly, however, the large amount of money now being raised for a monument to General Grant may create an opportunity for realizing still worse results.

By the number of its pieces of statuary, Boston, with oft-repeated claims for superior culture, comes next to New York, and shares the sister city's bad eminence in art matters. It is admitted that among her two or three dozen works there is one of real merit. This is likewise an equestrian statue of Washington. The others are up to the usual dead level of American commonplace, and if interesting at all, it is because they call to the mind of the beholder a great event or a notable name, which object could be as well attained by the carving of an inscription upon a slab of marble.* If Boston has failed in her statuary, it must be admitted that she has been more successful than other American cities in her buildings, of which there are a considerable number, public and private, that are worthy of admiration. Such structures as Trinity Church by Richardson, and the Boston Public Library now in course of erection, would do credit to any community, and their existence will atone for a long list of sins against the canons of good taste in other directions.

AMERICAN ARCHITECTURE.

The cities of the West and South show no improvement upon those of the Eastern and Middle States. Their architecture for domestic and business uses is bad enough, but that of their public

* A bill is now before the Massachusetts legislature embodying an appeal signed by a large number of citizens of Boston and by one artist, J. Foxcroft Cole. It asks for a commission which shall have power to accept or reject public monuments before they are completed, and settle where they are to stand. The mortuary monument to Colonel Cass, which was foisted on the Public Garden of Boston, has roused the citizens to this act of self-protection.—[February 15, 1890.]

buildings is infinitely worse, because of the greater size, and of the fact that they are as a rule incrustated with rude, uncouth ornamentation, and meaningless projections. The average American architect fairly revels in projections, and is seemingly never so happy as when put in possession of a twenty-five by a hundred feet lot and told to go ahead, regardless of expense. In a few months he will have succeeded in producing a front garnished with cornices, a considerable assortment of moldings, miniature pediments, semicolumns with capitals to match, and the whole completed by a massive flight of steps of sufficient dimensions for a large public edifice. Another peculiarity, fully developed from one end of the United States to the other, is the wood and zinc cornice painted and sanded to imitate stone. This device originated in the double motive of vanity and economy—the desire to get a large amount of show at the smallest possible cost. One of the natural sequences of these makeshifts is the mixed front of stone or brick and iron. These materials often come together, and when they do the parts composed of iron are usually regarded as ornamental, and are sometimes painted white so as to shine out in strong contrast with the red brick by which they are surrounded. The so-called “Grand Central depot” in the city of New York is a *brilliant* example of this exclusively American style. It can not be denied, however, that of the many thousands of buildings erected in the United States every year, a very small percentage of fairly good specimens of architecture could be selected. But it is certain that an exhaustive search for simplicity and reposeful elegance in the designs of either public or private edifices would not be attended with any considerable degree of success. Such an examination, however, would prove the one supreme fact in connection with our architecture, viz, that the average American architect upon nearly every occasion expresses his dislike of a plain surface.

OUR NATIONAL NEED OF ART CULTURE.

The preceding brief general statement, partly in the nature of an introduction, has been written for the purpose of bringing to the foreground in this report the great national need of sufficient art culture in our country to enable persons of ordinary intelligence in other matters to select designs for public and private structures which shall not be offensive to a hoped-for coming standard of fairly refined public taste, and shall at the same time form parts of an attractive whole when regarded as items in the composition of a city. What we require is a standard of culture which would compel the erection of artistic buildings and enforce the acceptance of better designs for public monuments. But the question how this is to be brought about is a complicated one, and clearly can not be solved by a report

upon conditions rendered apparent by art collections at a universal exhibition. The task of reforming and elevating the taste of a nation of sixty-five millions of inhabitants is not an easy one, and it will never be accomplished by the fine writing of elegant essays or the compilation of circumstantial reports. The reform will, at best, progress slowly, and must in the end come from an inwardly acknowledged necessity, rather than from outward pressure.

(1) The most careless observer of to-day will find many stubborn obstacles standing in the way of any considerable degree of improvement in art education. Among these may be set down, in the first place, the fact that within the last forty years the intercourse between America and Europe has increased a thousand-fold, and that the art perceptions of our people, as expressed by visible manifestations, are not as refined as they were before this means of easy and frequent intercourse existed. Conclusive evidence to sustain this assertion exists in the many thousand of overdecorated, overfurnished, overupholstered, ugly residences of a numerous wealthy class. These manifestations of the way to "overdo" it prevail in every city and considerable village from Maine to California, and it must be acknowledged that the conditions which bring about such results are to be found in the combination of wealth with that semi-barbaric desire for show that is indifferent to sham.

If this statement be true, it proves that our frequent intercourse with the refined nations has not improved our art perceptions, and would seem to indicate that we are beyond the influence of example.

(2) The vanity incident to and born of suddenly acquired wealth is a sort of *ignis fatuus* which leads the new-made man of millions to believe that he is really superior to his fellows, and now constitutes such a powerful element in our social structure that it has become a national misfortune. Those who form the millionaire class have worked themselves to the conviction that the same faculties or series of accidents which, as a rule, had placed unearned millions to their credit, would, if used in other directions, render them masters, without serving the necessary time to make them expert workmen. The perfectly well-defined assumption of superiority and right to leadership which in the United States pervades this acknowledged all-powerful class, is a formidable obstruction in the path which might lead to a high general plane of intellectual development, and it would moreover neutralize to a considerable extent any general movement in the interest of refinement in matters of art.

The statutory restriction upon the importation of works of art has, to a very considerable extent, barred out essential elements which must be a part of any scheme for our higher education in æsthetic matters. It has raised up a class of dishonest tradesmen who, presuming upon the credulity born of ignorance, produce rubbish which is passed off upon those unable to discriminate, and in

most instances takes a place which should be occupied by works of real value. The same desire for the artistic adornment of one's dwelling that impels the purchase of a sham, would induce the buying of something really meritorious. In this relation as in others that could be cited, the operation of the thirty per cent. act has become especially vicious. It has created and encouraged the production of bogus pictures, and it indirectly assists a newly fostered set of knaves to cheat the ignorant. We may search in vain the history of western civilization and of legislative enactments for a parallel of this provision against the arts. It is the only instance where the law-making power of a great country has interposed the force of its will against the free right to acquire those productions of genius which are the most valued possessions of the refined nations, and its existence in our statute book may be regarded as an extreme illustration of the emptiness of our pretension to occupy a higher position in the history of the civilization of the nineteenth century.

In Italy the Government retains the right of controlling all works of art, ancient and modern, which are in the country, and none can leave it without an official permit. In other European countries government competition is frequently encountered when really good works are offered for sale, and so strong is the love of the artistic among the European peoples, that those who produce notable works are esteemed public benefactors. These conditions arise from a belief that a cultivation of the arts refines, and that a love of them assists to soften, the hardness and aggressiveness incident to the commercial occupations of everyday life.

An important condition to be completely established before we can hope for any general elevation of ideas relating to the arts in the United States is, that every person shall have the right to purchase, free from Government tax, and to bring into the country any acknowledged work of art not produced by mechanical agencies. That such works are luxuries for the wealthy, and are purchased for the personal gratification of the buyer, is no argument against the unqualified right to acquire and to import. It would certainly be better if the General Government, the States and municipalities were to obtain them for public collections; but of course the American citizen of average intelligence knows that so long as the nation is ruled by "practical politics" no such desirable end can be expected. The people have the right, however, to demand of their rulers that such laws shall be enacted as would in every way encourage the citizen to enrich his collection, since it is from private possessions that the majority of the existing public galleries in the United States have been formed. Therefore, the writer is clearly of the opinion that the repeal of the thirty per cent. act would do more in the direction of fostering and encouraging a national taste for the arts,

than hundreds of reports setting forth the condition of art in foreign countries.

ART IN FRANCE.

Profound admiration and a lively sense of appreciation of official duty compel me to acknowledge the greatness of a refined nation, whose energy and spirit devised the means and method for bringing together within its boundaries the greatest and most comprehensive collection of material for object lessons ever assembled. Whether it be regarded as an unusual opportunity for the amusement of the casual observer, or a great school for the student, the success of the Universal Exhibition of 1889 is one of unparalleled splendor and completeness. If the exhibition has proved one fact more than another, it is that in the world of art the French have reached a higher standard of true excellence in many respects than any of the other nations. While several have retrograded to a level of commonplace, the French have achieved a steady advance, and no year, of late, has passed without showing new evidence of the substantial value of their schools, the industry of their students, and the good effects of intelligent Government supervision, together with discriminating national patronage. This last is bestowed with a free hand, not only to enrich the museums of the larger cities, but also for the purpose of forming good collections in many of the lesser towns. To good instruction and liberal patronage may be ascribed that continuous and lively interest in everything that pertains to the artistic which seems to pervade all ranks of the French people. A good record at the art schools, and a hope of substantial Government recognition, are incentives for hard work, and they induce a constant striving for higher degrees of excellence.

EXTENT OF ART INFLUENCE IN FRANCE.

It must be clearly understood that these references to the state of art in France are not made upon the narrow lines of the professional art critic, who as a rule writes only technically of particular objects. If we would rightly comprehend the full force of all that has been accomplished by the schools, we must accept the entire results of artistic training in their broadest and most minute significance. We must look into and study their relations to the everyday life of the people. Here is an especially fruitful field for observation, for within its boundaries we shall have occasion to examine everything in use for personal comfort and convenience. In domestic architecture we see general uniformity of design, of which the chief characteristic is studied simplicity. The whole consists of a combination of simple lines, flat surfaces, moderate projections, unobtrusive ornamentation, and, when needed for actual use, balconies. The

interiors, according to well-established principles, correspond to an acknowledged national formula as to convenience and comfort. They are subdivided with especial reference to economizing space and insuring a liberal amount of light and ventilation, and are, as a rule, appropriately decorated in accordance with the dictates of refined tastes. In the better French houses—those occupied by the upper and well-to-do classes—the stuffs and furniture are always artistic, and they often rank high enough artistically to be regarded as beautiful creations of the imagination. Never in these residences do we find a ceiling overloaded with a combination of crude colors expressing a complexity of kaleidoscopic design, the whole meaning nothing, and showing nothing but a confusing surface of meretricious stencil ornamentation, born of bad taste and unlimited bank account, and a desire for something worse than barbaric display.

REFINEMENT OF DAILY SURROUNDINGS.

Refinement of daily surroundings is the most important among the elements needed for the superior education of the individual. A boy nurtured and brought up under the influence of good forms and harmonious colors would, when he reached the adult period of life, be perfectly certain to select the most artistic productions for his own home. The knowledge which enables him to do this is the result of direct contact, but it comes imperceptibly, without effort or special teaching. These surroundings make men and women more considerate, kind, and reserved in their intercourse with each other, and help to give refinement to the transactions of everyday life. Prize-fighters, wife-beaters, and tobacco-chewers are not results which flow from the source that irrigates the arts. No doubt the *salon* has furnished its share of characters whose names are to be found in the world's record of crime, but their misdeeds have scarcely been on the level of the brutal murderer's, or those of the sneaking cut-purse.

HOW TO HELP THE WORKING CLASS.

The practical solution of the slum question in the large cities is almost as far off now as it was fifty years ago. The success attending the efforts to improve the condition of the world's unfortunates who fester in fetid holes has not kept pace with the increase of their number. Church organization and governmental methods to raise the morals and ameliorate the physical condition of this burdensome class of human beings have not shown the best results attainable. But now a new light is breaking through the clouds; the comparative uselessness of the old theories and methods has become apparent, and there are tangible indications of a fresh departure in a practical direction, which, if developed on a large scale, may prove to be of

inestimable value to the most unfortunate of the toiling classes of society. The liberal bequest, now intelligently directed, of the late George Peabody, for the erection of workingmen's homes in London, not only set the fashion in England of giving money with a similar end in view, but led the rich and benevolently disposed to think about the best method to be employed in order to secure the substantial improvement of the classes intended to be benefited.

MODEL HOMES FOR WORKING PEOPLE.

The erection of the first group of houses from the Peabody fund, and their immediate occupation, showed beyond all dispute that a move in the right direction had been made. These buildings were well ventilated and lighted; the rooms were of fair size, arranged in convenient groups, and let at moderate rents. As fast as ready for occupation they were eagerly sought after by people of the working class, whose mental and physical condition has been greatly improved by the change. Several of the most recently erected of these workingmen's homes, built by London philanthropists now living, exhibit a considerable advance in the matter of internal arrangement upon those first constructed out of the Peabody fund. One occupies an irregular quadrangle of goodly size, with a court in the center, where are to be seen, a fountain, flower-bed, turf, and group of shrubs. The building fronts upon four streets. Every room and passage is well ventilated and lighted; there are bathrooms and closets with water in abundance on each floor. broad flights of stairs with graceful turnings at each stage. The carpenters, masons, and painters' work is appropriately artistic, and sufficiently ornamental to comply with the reasonable requirements of refined taste. The whole is of a most cheerful and inviting aspect, and to those who have been used to rearing families in rooms 7 feet by 9, these homes must seem an earthly paradise. The building described is not far from one of the lowest quarters of London, and is largely occupied by former inhabitants of a well-known slum. Their conversion to decent habits, and reclamation from the lowest depths of depravity, was almost immediate. The first indication of improvement usually showed itself in a growing appreciation of cleanliness, and then, in regular order, came less drunkenness, less wife and child beating, and less foulness of speech. With these signs of improvement was observed a gradual development of a love for the beautiful. Money which a month before would have been spent for drink, now went for a pot of flowers, sometimes an engraving or photograph, a piece of china, or a bit of glass. The artistic and comfortable surroundings which the poor pack-carriers for the more fortunate classes of humanity found in their new houses, turned out to be the true harbinger of peace and rest, and the most potent expression of good will from man to man.

Here we have the proof that it is possible in less than one generation to raise from the lowest state of ignorance, wickedness, and despair, a large class of human beings whose depravity seemed to be beyond the reach of human aid. Are we not compelled to admit that in this particular field, so fraught with good results, it was the application of the artistic to comfort which constituted one of the chief factors in the transition?

If this proposition be granted, why not urge upon our successful stock-waterers, unprecedented land-grabbers, and the magnates of trusts the importance of an extension of this application of the arts to the useful, in the interests of the poor, and also as an expiation for their numerous offenses against the interests of States and the rights of citizens? In no better way could their ill-gotten gains be disbursed, and in no other manner could they so appropriately make some reparation for their gigantic crimes. If in the future it should appear that the reading of this report had caused one of these offenders to offer substantial evidence of his repentance, then, in the words of the Secretary of State, it would have proved to be of "practical benefit to our fellow-countrymen."

RURAL HOUSE-BUILDING IN AMERICA.

There is also another sphere in which a little knowledge of the art may be usefully applied; this is a broad field, worthy of the utmost cultivation. In the rural districts of the United States, from our northeastern boundary to the southern end of California, we are afflicted with complications of ugly rusticity in dwellings, without parallel in other countries, which may be designated as the national makeshift wooden shanty architecture, so cheap to build, so expensive to keep in repair, so cold in winter and so hot in summer. First and foremost amongst these, standing out in its offensive relief against land, water, sky, and forest, is the white painted, peaked-roofed, enlarged dry-goods box with green blinds, which a want of imagination in our early New England ancestors caused to be handed down to posterity as a dwelling house. No doubt when this curiosity in rural house-building was invented, its inventor congratulated himself upon the fact that he had found a way out of the log-hut period. But what a mistake! While the one is an insult to all the beauties of nature by which it is surrounded, the other, on the contrary, erected on the green sward and buried picturesquely among the foliage of the forest trees, blends into and completes the beauty of the general picture, like a part of nature necessary to the scene. Often the owners of these habitations, not taking into consideration that the offense of such objects existing is bad enough, add to it by placing them as near the street or roadside as possible, where there is neither shrub nor tree to neutralize the chill their presence inspires. This location is often selected with the motive of

saving land where it is comparatively worthless; add to such a house a flanking fence of long rough boards, nailed to posts at right angles and whitewashed, and the picture is complete.

Another, and if possible, even worse monstrosity than the house in white, is the architectural effort of the great man of the village who has made his mark in the circles of finance. He often affects the elaborate, but does so with the scroll saw and the paint pot. With these he will produce a rare jumble of cupolas, false and real chimneys, seeming gables supported by iron rods, variations upon Dutch roofs, balconies everywhere, piazzas on all sides, heavy projecting cornices, etc.; each part painted a different color, and the whole when completed suggesting a serious attempt to combine for domestic use all known mathematical forms. But the owner is usually satisfied, for he knows he has got the worth of his money, and that in his own woodpile all colors and forms are represented.

With us there is much important work for art to do outside of its influence in shaping the appearance of material things. Its mission is not only to add grace of form and correct color to things in daily use, but also to infuse, if possible, just a little sentiment into the never-ending roar of the mills which grind for mammon only. Perhaps a new departure in the interest of the arts would soften the hard, metallic, almighty-dollar music to which the whole nation is now so proudly and boastfully marching.

UNPROFITABLE TRAVELING.

Our people seem to regard art as an abstraction instead of a living and useful quantity, and the majority of them are satisfied with a rapid foot-race through European museums of painting and statuary, which they count as pleasingly curious. They congratulate themselves upon having "done" the Louvre and the Vatican, and at the end of the "grand tour" are sincerely glad that the business of sight-seeing is over. Their contract with themselves as to time and territory to be covered being completed, they return home to resume their usual occupations, to build as ugly houses as ever, and fill them with as inartistic furniture as those in the possession of their untraveled neighbors. Their foreign travel has been of no value to them in the way of education, for now, no more than formerly, do they stop to reflect that a handsome chair, a pitcher of good form, or a carpet showing artistic composition of colors and design, need not be more expensive than the badly designed rubbish presented for their approval by the ignorant manufacturer, whose machines merely respond to the creations of his untutored mind.

METHODS OF IMPARTING KNOWLEDGE.

The painter of a fine picture and the creator of a great statue are entitled to very high places in the records of civilization; but

the interests of their works in this materialistic period of the world's history is very limited. They exercise no perceptible influence in forming the sentiment or elevating the morals of communities or nations. Professional writers, art critics, curators of museums, dealers in art, and the very wealthy purchasers of artistic works, are about the only classes affected. The art work, the need of which is chiefly felt in our century, must come from active agents; a fine picture hanging upon a wall, or a noble statue standing upon a pedestal, are important elements in a general scheme, but an unlimited number of collections, composed of the best works, would never reform the taste of a great nation.

INFLUENCE OF THE SOUTH KENSINGTON MUSEUM.

In the South Kensington Museum—with its means and adjuncts for teaching—we have an illustration of what can be done by an active vital force. In its short existence it has accomplished more for the general diffusion of art knowledge and love of the beautiful among English people than all the inactive art collections of Great Britain put together. The reason of this is neither remote nor obscure; it exists in the fact that it is a vital force, while the others are a passive quantity only. The South Kensington Museum injects its influence into the everyday life of the people; the others invite the gaze of the lovers of the beautiful and curious, but are like preachers whose sermons are delivered with folded arms and closed eyes.

That great school, founded by the late Prince Albert, one of the most thoroughly enlightened men of our time, became at once a potent influence in the cause of art among the people of the British Isles. It has proved of inestimable value to them, and its influence is now felt in the remote corners of Her Majesty's dominions.

THE BEST WAY OF SPENDING THE SURPLUS.

The United States need at least three such collections and schools; one for the East, a second for the Mississippi Valley, and a third for the Pacific slope. And there can be no better way of "getting rid of the surplus" than by expenditures judiciously and intelligently made for the establishment of such schools, to be placed under Government control. Our people are now forming what might be appropriately called in social geology the palace strata. What better business can our National or State Governments engage in than that of educating not only our fast-growing class for the palace strata, but likewise all classes of our people, up to a certain standard of knowledge concerning art values, as necessities which ought to find expression in our everyday surroundings?

The artistic should be the rule, the inartistic the exception.

THE UNIVERSAL EXPOSITION OF 1889.

The Universal Exhibition of 1889 will pass into the history of the nineteenth century as one of its greatest achievements. It was conceived and carried out in a spirit of catholicity far beyond that of either of its predecessors, and became such a success as to entitle it to a notable position in the history of civilization. In such an enterprise no combination of individuals, however powerful or wealthy, could have accomplished anything like the measure of its completeness; only a united and enthusiastic people, proud of their nationality and traditions, working together for the accomplishment of a great object could have achieved such a brilliant triumph.

It is difficult to decide which department stands first, in the estimation of those capable of judging, or which was most complete. In almost every sphere where human energy has been applied the best that has been done was represented, and under those temporary roofs the student in search of knowledge could have found nearly all that has been accomplished in every field of human endeavor. The sciences, arts, and industries were fraternized; and no path trodden by the genius and industry of man was neglected.

Never before in such variety and quantity have the productions of the arts and manufactures been brought together; never before has it been so difficult to decide where the industrial arts leave off and where the fine arts commence, so imperceptible are the dividing lines, if they exist at all. The field of the industrial arts has of late so broadened, and it now comprehends so much that there is practically but a thin partition between them and the fine arts proper as heretofore recognized. In many of the industrial sections were displayed works of various kinds which in design and execution showed an art value far superior to that of some paintings and statues in the *Palais des Beaux Arts*.

This assertion is particularly applicable to tapestries, silk stuffs, carpets, made-up dresses, laces, combinations in furniture, wood carving, metal work, designs in gold and silver smith's work, ceramics, and glass. The men who composed the designs for some of these beautiful things for daily use were, in many instances, artists of no mean pretensions, thoroughly educated, possessing great creative power, and worthy of places in public estimation quite equal to those occupied by gentlemen who spoil canvas with paint, and those of another kind who, without the art instinct or the education of a school, build bad statues to order at so much per ton.

TENDENCIES OF MODERN ART.

It can not, however, be admitted that the best in an artistic sense now produced by industrial processes is better, more original, or as good as in the past. During the Renaissance in Italy, and at a

later period in France, the application of the beautiful to the useful was carried to a degree of perfection not since attained. What may be said of the present is this, that there is less imagination among painters, sculptors and designers, and more general knowledge of *technique* than there was three hundred years ago. The effort now seems to be to send art down to its original starting-point. Painters are doing the work of the photographer, but with brush and palette instead of with a camera. Nine-tenths of them paint only what they see, and never what they feel, for they feel nothing; never what they imagine, for they imagine nothing. The manufacture of a salable commodity seems to satisfy their craving for the artistic; and, judging from their works, we are forced to the belief that their inspiration, if they have any, comes from matter rather than from the ideal. They transfer to canvas in a mechanical way just what they see. External objects are always to hand. The artist tries to copy, but does not compose or construct pictorially a work of art. His *technique*, which the schools and ateliers teach him, he regards as a very useful stock of tools. His teaching answers the same purpose as does the regular outfit of a carpenter when he leaves his apprenticeship and commences business on his own account. It is a lamentable fact that a very large majority of the artists of the present day start out like the carpenter, to make a business, and apparently care very little for art.

INFLUENCE OF ART DEALERS.

The natural result flowing from this indifference to the poetic and imaginative in art, is a gradual sinking down to a low level of realism, void of design, interest, or intellectuality. To this state of things no set of men have more persistently directed their pernicious influence than the dealers in art. No other fraternity during the last quarter of a century have more successfully sounded the depths of the pockets of the new-made millionaire, than they. They have filled the art world with false gods which fools in abundance have fallen before, and created and encouraged manias which have taken deep root and fructified in the rich soil of ignorance and mammon.

Facts illustrating the truth of all this could be cited by the hundred, but a very few examples will suffice. Twenty-five years ago the portrait of a trunk of a tree in the forest of Fontainebleau, painted by Diaz, brought in the United States about twenty-five dollars, sometimes as much as fifty. Soon after his death the dealers succeeded in putting such performances up to about a thousand dollars, and they have remained near that price ever since. It has been stated that at the time of Corot's death, a certain Paris picture dealer had on hand a hundred and twenty-five of his works, and other dealers in that city were also well stocked with them. The body of the dead artist had hardly time to cool when the dealers' "boom" started, and

within a very short period they succeeded in putting up the price at least twenty-fold, and from out their dark corners they supplied good, bad, and indifferent Corot's, to an almost unlimited extent. Even now, a canvas with the name of this artist upon it, no matter how weak, false, or indifferent in execution it may be, will bring an enormous price, entirely out of proportion to its real value. But the great marvel of the nineteenth century in the way of creating fictitious values is best illustrated by reference to the sales of works by Millet. Good, bad, and indifferent alike bring prices far beyond those previously paid for the best modern masterpieces, and of the old masters only the "Blenheim Raphael" has sold for more than the price said to have been paid for the "Angelus." It seems incredible that the works of this artist, the very large majority of which are devoid of grace, interest, imagination, or beauty of any sort, and have often been executed without much regard to the correct drawing of the human figure, should command the enormous prices they do whenever they are offered for sale. The "Angelus" is an exceptional work, for there is in that a charm of sentiment, and an expression of the reverential, seldom found upon canvas. The way in which the hour is expressed, and the attitude of the figures, are in perfect harmony with an admirable idea.

Couture was once asked his opinion on Millet's works, and the following was his answer: "To-day we see a canvas upon which is uncouthly painted a rough peasant standing before a log of wood; three months later we see upon another canvas, the same peasant with the same log of wood upon his shoulder; three months after, upon a third canvas, there appears the same log, but this time upon a fire, and our friend, the peasant, as badly painted as in number one, is standing in front of it and looking at it burning, and so ends, in three chapters, Millet's great story of the peasant and the log of wood." Nothing could more thoroughly express an absence of imagination than this graphic description by Couture, so perfectly in accordance with fact. To the writer of this report, Millet's work seems in an inartistic and imperfect manner to express only the grossest, most unpicturesque, and most uninteresting realism. His subjects, as a rule, were unworthy of a great master; his human types nearly express idiots or monsters, who could not have existed out of asylums, and if the portrayal of them exercises any influence at all upon humanity, it is quite certain that it neither elevates nor refines. The boors of Teniers the younger, Steen, Brouer, Adrian Van Ostade, and Hals, are infinitely more interesting than those of Millet, and to-day the works of these great artists give us a better insight into the habits, manners, styles of dress, ways of living, and amusements of the common people of their period than all the written histories of the Low Countries ever printed. While the men and women of the Dutch and Flemish

artists are often found in interesting groups, dancing, singing, and otherwise having what might be called a "good time," those of Millet are generally engaged in such operations as carrying sick calves, hog-sticking, an idiotic monster leaning upon a hoe, etc., in which the majority of mankind do not take the least interest.

THE SALE OF THE "ANGELUS."

Apropos of the subject, and while the ink with which the foregoing paragraphs were written was still drying, something characteristic occurred in Paris. The Secrétan sale, which had been worked up to white-heat point by two shrewd firms of Paris picture-dealers, aided by paid experts, auctioneers, newspapers, and art critics generally, as no other sale had ever been before, was about to take place. The penny-a-liners asserted in their most authoritative style that the whole world was on the tiptoe of expectation and feverish anxiety as to the coming fate of the "Angelus." Monarchs were supposed to have passed weeks of dinnerless days and sleepless nights, tormented with anxiety; senates and parliaments had adjourned pending the great event, and whole business sections of great cities had abandoned their usual occupations, until the momentous question should be settled; while, according to the newspapers, this painful suspense was imperiling the peace of Europe, there came a chilling trumpet blast from England which in tones portentous told to the startled European art worshipers the discouraging news of the arrival of the agents of the Corcoran Art Gallery of Washington upon the shores of Britain. They, like some awful giants of fabled story, were coming to carry off the coveted treasure which all the nations of the earth were determined to own. Then was heard the thrilling story of their late landing at Queenstown, their catching of the Irish mail, their hiring at Chester of a special train for \$400, which carried them to London at the rate of 64 miles an hour, and then of their further timely advance upon Paris, much to the consternation of the monarchs and the rest of European mankind. By a singular decree of fate the "great sale" commences immediately upon their arrival; but the 500,000 francs which they bid, did not (fortunately) obtain the immortal work. A self constituted-agent of the French Government succeeded in capturing the prize for the sum (on paper) of 553,000 francs, which his Government very promptly and properly refused to pay. The gigantic farce ended by the "inestimable treasure" going into the hands of a firm of New York art dealers for the rumored sum of 580,650 francs.

The authorities of the Corcoran Gallery are to be congratulated upon the failure of their agents, who had shown their willingness to pay \$100,000, in making the most thoroughly foolish and unwarrantable art purchase ever known. The enormous amount of money which they were willing to so misspend could have purchased fifty

of the finest examples of works by the best living masters, which were then for sale and to be found in the *Palais des Beaux Arts* at the Exhibition. These works if purchased and placed upon the walls of the Corcoran Gallery, would at once have made that collection the great art feature of our country.*

THE OBJECT OF WHAT HAS GONE BEFORE.

The preceding portion of this paper has not been written in strict accordance with the terms of the letter of instructions. The writer, however, has followed his instructions to the letter in this; that in trying to point out what to do and what to avoid, he has had the benefit of the people of the United States constantly in his mind. But the stage has now been reached for considering and reporting upon the state of art in the year 1889 "as shown at the Exhibition." An exact compliance with this part of the instructions would compel the writer to devote to it the rest of his life; consequently an exhaustive, specific, technical report upon particular exhibits, will not be attempted. What follows is a general statement, somewhat historical, in relation to teaching, institutions, and remarks upon the present condition and plans of the fine arts, as illustrated by the most important objects shown at the Exhibition.

THE TECHNICAL STRENGTH OF THE FRENCH SCHOOL.

At the threshold of this investigation stands the fourteen hundred and eighty oil paintings which represent the last eleven years' work of the great body of living French artists. Although the works of some notable painters are not included, the collection may be said to cover the field. It is chiefly remarkable for its technique, which certainly in no assemblage of modern art has been surpassed, if equaled. Here is clearly told the triumphant story of the school, its masters, and the high standard of work demanded from their disciples. Nearly every canvas indicates a fair amount of severe training in mastering the elements; and while only a comparatively small number of works have reached general excellence, a high standard of the merely mechanical part of the art of painting is plainly apparent. In painting, as in every other branch of human

* Not many years ago there lived in an Eastern city a man who posed for a great artist, and the community in which he lived accepted him at his own valuation. One day he died and soon after his studio effects came to the hands of the auctioneer. A gentleman of one of the interior cities of the State of New York, an affected "art lover," who desired to possess one of the "gems" that had fallen from the great man's easel, attended the sale and carried back to his home a piece of rough paper smudged over with charcoal. Up to this day neither the owner nor his art-loving acquaintances have been able to decide which side up this seventy-five-dollar "gem" should be hung. This anecdote illustrates the average common sense involved in the usual "art craze," and is here cited as a warning. In countries where the English language is not spoken art manias, as occupations, do not succeed.

endeavor, the accomplished student or the expert mechanic may turn out a coldly correct piece of work, but it is only the genius or man of exceptional talent who, besides knowing the mechanics of his calling, is inspired by a wealth of imagination which enables him to astonish the world with a great masterpiece. This universal rule is as applicable as ever it was in the past to the French artists of to-day, and if it were not for their splendidly equipped and exacting school they would possibly produce no better technical work than their struggling brothers who live in countries where there are no schools, but where each individual worker strives to be a school unto himself.

ARTISTIC INSTINCT OF THE LATIN RACES.

Therefore it would be surpassingly strange if, under the favorable circumstances which surround the French art student from the outset of his career, he did not produce better results than are achieved in other countries. But it is not to the school and masters alone that he is indebted for his exceptional success. He, first of all, has for art purposes, the advantage of being of the leading Latin race, which is a great help to him, gained by the mere accident of birth. That there is in the human race such an intangible quality as the art instinct there can be no reasonable doubt; and that it has been more marked and strongly developed among the Latin races than among the northern people, is also indisputable. If the history of art proves one thing more than another, it is the value of this instinct in the development of painting, sculpture, and architecture among the southern races. To the influence of the Greeks, and, in later times, the great era of the Italian Renaissance, is the northern part of the civilized world indebted for much that is good in its art achievement. But in no country has that double influence taken such deep root and retained such vigorous life as in France; in no other has it produced such far-reaching and beneficial results. In that country it has kept alive a natural love for the artistic, which even in these materialistic days of steam and iron adorns every phase of national life.

THE INFLUENCE OF GREEK IDEAS.

Jacques Louis David, born in 1750, was called by his countrymen the head, and also restorer of the French school. It might more appropriately be said of him that he introduced into French art a correct knowledge of the nobility and grace of the Greek forms, and that he accomplished this by executing all his earlier and more important compositions in strict accordance with the severe requirement of classic taste. To his influence, more than to that of any other individual, is the French school of to-day indebted not only for its existence, but for the excellence of its teaching as well. The

success of his efforts stimulated such men as Gros, Girard, Girodet, Coignet, Flandrin, Delaroche, and others, to work on his lines, and through them came down to the time of Couture, in a stream of unbroken continuity, the influence of the founder's teaching which fittingly culminated in Thomas Couture's immortal work, "The Decadence of the Roman Empire." This beyond all doubt is the most comprehensive and completely artistic composition that the brush of a painter belonging to our times has given us. The composition, epitomizing as it does an important period in the history of the greatest nation of antiquity, the correct drawing and suggestive grouping of the numerous figures, the warmth and richness of color, tell the well-known story of debauchery and dissipation, sapping the physical vitality and destroying the *morale* of a great people, as it was never told before. With the birth of this noble work there died nearly all that was left of the positively Greek influence, which for nearly a hundred years had been such an important factor in the development of the French school of painting.

BREAKING AWAY FROM CLASSIC INFLUENCE.

While the gradual decline of classic influence was going on, running *pari passu* with it was an evolution of something new, which in the end was destined to give wide scope to individual effort, and to lessen the purely academic force of the circumscribed teaching of the school. The restive spirit of the nineteenth century had sown its seed, and in due time a harvest of new men was ripening—men who displayed great technical skill and talent for new styles of composition. Many of them, after the years of academic drudgery were passed, abandoned the traditions of the school, started out upon fresh lines, and created what might almost be denominated new fashions in art. Their work soon assumed a highly decorative form; subjects were selected with special reference to telling or pleasing situations, which afforded opportunities for the display of very decorative schemes of color. For nearly half a century the only notably outstanding exception to this rule was in the work of a few artists, who formed what is now known as the "Barbazon school." The men constituting this little band of earnest workers were artists in the truest sense of that much abused term. They pursued the more conservative course, and confined their efforts to delineating in a marvelously truthful, striking, and often poetic way, such choice bits of nature as only those possessing the art instinct most highly developed could discover and portray.

From what has been written the inference will be rightly drawn that, in the belief of the writer, there exists in France a national school of art technique, such as no other nation can show. It seems necessary to set forth some of the reasons or facts upon which this opinion is based.

THE SYSTEM OF ART EDUCATION IN FRANCE.

The most important set of facts upon which this conclusion rests, relates to the connection of the Government with the art education of the French people. Coupled with the State Department of Public Instruction is that of the Fine Arts. The member of the cabinet who directs these departments is accordingly styled: "*Ministre de l'Instruction Publique et des Beaux Arts.*" This functionary has under his control all the national museums in France. To him are referred all propositions for the purchase of works of art from the public funds for the collections in different cities. Models for statues and designs for public buildings, together with the interior decoration of these last, have to be approved by him. Librarians, directors, curators, keepers of prints, and all experts who have to do with the artistic and antiquarian collections belonging to the public, are appointed by him, and it is to the credit of these ministers, who have existed from the time of Louis XIV, that their appointments in connection with the arts have usually been made with special reference to the fitness of persons for the duties they had to fulfill. It is assumed in government circles that only a long course of special training can prepare a man for the responsible position of director of a great collection, and this business has been so arranged that there is always a competent and acceptable expert ready at hand, who can at a moment's notice fill any important vacancy that may occur. One of the results of this perfect system is that no country in the world can present a longer line of illustrious men who have created and presided over great collections than France. These officials are held in high esteem, honored with many marks of distinction, well paid, and pensioned when their days of usefulness are over. In France there is no national quality more clearly apparent than respect for the arts and works of all kinds connected with them. This trait belongs to no condition nor class, but pervades alike all ranks of society. There, as in other countries, the fame of the average politician is usually short-lived: but the protectors of the arts build monuments which keep their names remembered, because they have delighted and instructed thousands of their fellow-men.

STATE ENCOURAGEMENT TO STUDENTS AND ARTISTS.

Another important element to be considered in relation to this subject is the direct and substantial encouragement which not only natives but foreigners studying in France receive from the Government. The spirit of the French people is so broad and catholic in all matters pertaining to art that they make but little distinction between the productions of native and foreign artists, and the consequence is, that the works of living men of many nationalities may

be seen, hanging side by side with those of natives, in all museums and exhibitions to which contemporary art is admitted.

The national budget of each year contains a liberal appropriation for the purchase of works of art and for the proper maintenance of the national collections. From this fund annual purchases are made, chiefly from the works exhibited at the *salon*, and these are distributed among the galleries of the different cities. In each distribution, little distinction is made between the national collections and those under the control of and owned by the municipalities. These last are often enriched by important gifts from the Government.

The artists appreciating this national recognition, and the advantages of the encouragement they receive, in a spirit of reciprocity frequently accept comparatively low prices for their better works when purchased for the public galleries. That their works should have been found worthy of such distinctive recognition is regarded by them as an especial honor. In no other country is the *entente cordiale* between government officials and artists so complete. The former recognize the value of the arts as one of the most important elements of success in the great combination of social and political forces which has come to be known as modern civilization, and the latter, heartily responding to this enlightened recognition, exhibit an honest pride in working for the promotion of a nation's refinement.

SCHOOL OF PAINTING.

Of late so much has been said and written about the superiority of the "French school" over all others of these later times, and its popular, artistic, and commercial success being well assured, a brief inquiry into its exact status appears to be necessary here, for the purpose of ascertaining if in reality it has an actual existence, *i. e.*, in the ancient or any other acceptation of the term "school of painting."

When an author cites the school of Bellini, Mantegna, Da Vinci, or Titian, the reader who is at all versed in the history of Italian art comprehends the exact meaning of the expression, which in its broadest signification has a rather narrow application, and refers usually to the pupils (and imitators) of this or that master, when they were numerous enough to be called a school and followed the method and style of their teacher. In the days of the early Italian painters there were no academies with a corps of professors for teaching the arts, and probably for that reason the master became, as it were, a school by himself, and his pupils and their followers maintained the technical traditions of the particular studio.

We also know what is meant by the term "Venetian school." The visitor to Venice, enchanted by the richness of color, and the rare nobility and grace of form which greet him in every public

building, church, and palace, does not usually stop to ask the name of the artist whose imagination gave birth to this or that exquisite composition, but contents himself with the fact that he is in the actual presence of one of the great and fascinating masterpieces of the "Venetian school;" and not only the individual, but the civilized part of the world, acknowledges the force and art value of this comprehensive expression. Neither recorded nor existing facts warrant the conclusion that any single French artist living within the last half of the century has been the founder of his own or the promoter of any other school of art. The demands of the times do not encourage imitations. Students are now taught the elements or the handiwork of their calling, rather than how to paint pictures in a particular manner. The best imitations meet with but little encouragement, while often poor original work brings unexpected approbation, not only from the amateur but from the man of commerce. The fortunate want of demand for imitative work has completely done away with the necessity for the individual school, and hence it is that we never hear of the school of Couture, of Meissonnier, of Gerome, or of Bonnat. It is greatly to the credit of these, and many others of the later French masters, that they have never attempted to hamper the breadth of their teaching by the narrowing boundaries of a school.

Since the Dusseldorf days there has been no concentrated attempt to found a school of art, and that attempt; after a few years of nominal success, turned out to be such a failure that its history has no doubt prevented artists in other countries from repeating such an experiment.

The school at Munich still exists, and continues to receive and instruct students, but its success over its older rival consists chiefly in the fact of its having lasted longer, rather than its proved capacity to make artists.

A few years ago there appeared a small circle of enthusiasts who were given to the worship of unearthly and strange things. They called themselves "Impressionists," and labored under the impression that they had found a new key with which to unlock the secrets of nature, and a new route to fame. They told their little circumference in the world that they had discovered something new and had founded a school; but the greater world refused to listen or believe, and their bantling still languishes in the swaddling clothes of a fruitless attempt.

THE ÉCOLE DES BEAUX ARTS.

Notwithstanding the fact that there does not exist in France a school of art in the popular acceptation of the term, there is a source of knowledge—a place for teaching all that can be taught in the way

of certain rules—and it is known as the “École des Beaux Arts,”* and was under the control of the “Académie des Beaux Arts,” and is now indirectly under the direction of the Government. It generously receives from all quarters of the globe those who would cultivate a knowledge of the arts. Formerly examinations for admission were rather superficial, and were seemingly made with special reference to granting easy access. Now, however, owing to the prospective crowding out of natives by a great and ever-increasing influx of foreigners, they have become more comprehensive and exacting; not more so, however, than they ought to be to prevent the waste of valuable time bestowed in teaching the simplest rudiments. The examination passed successfully, and without any payment, the student enters his class and becomes entitled to all the privileges and advantages of the academy. He may continue his studies for an unlimited period, as there is no particular time prescribed for them or regular course insisted upon.

Students upon entering choose their course of instruction either in painting, sculpture, or architecture. In all of these branches the best teachers available are appointed to instruct, and they, as a rule, visit their classes for a short time each day, for the purpose of inspecting and correcting the work of the pupils. The instructors who accept these appointments are acknowledged masters, and are usually among the most successful in their respective branches. They must make a great sacrifice by undertaking these duties, which compel them to devote a considerable portion of their time to an occupation for which they receive no adequate compensation. This remarkable evidence of *esprit de corps* may be accepted as conclusive proof that those who pursue the arts in France are possessed of great love for the higher interests of their vocation.

COURSE OF STUDIES.

The studies at the “École des Beaux Arts” are divided, as already indicated, into three sections. These are:

1. *Section of painting.*—In this is included instruction in engraving upon metals and etching. The students must draw from nature and the antique, and copy from selected old masters: they must also study anatomy, perspective, archæology, costume, modeling, elementary architecture, geology, physics, general chemistry, and especially the chemistry of colors.

2. *Section of sculpture.*—In this section the art of engraving upon

* There are in Paris several private art schools for painting and sculpture, which in their teaching as to *technique* cover the field occupied by Government institutions. The most successful and better known of these is called “the Julian,” after the name of its director, M. Randolph Julian. This is a well-organized school, and possesses every facility for a thorough course of technical instruction. Among its masters are to be found some of the best known teachers, and the fees are moderate.

metals and precious stones, is also taught, and, with the exception of modeling from nature and the antique, the general course of study is about the same as in the section of painting.

3. *Section of architecture.*—This is the most extended and comprehensive of the three courses, and embraces the study of various sciences, including mathematics, descriptive geometry, stereotomy, perspective, construction, ancient architecture, drawing working plans, sketching from fragments, from nature, and the antique. In connection with each section there is an extensive course of literature, and a series of special lectures, historical and technical, is given, applicable to each order of study, and free of charge. Besides the direct teaching of masters, the pupils of all the sections may copy and read at will in all the galleries, museums, and extensive art library attached to the school.

HISTORY OF THE ÉCOLE DES BEAUX ARTS.

In 1635 Richelieu instituted the “Académie Française,” and in 1648 the foundation of the “École des Beaux Arts” was laid. It was then called the “*Académie Royale de Peinture et de Sculpture.*” That year was made famous by the peace of Westphalia, which put an end to the Thirty Years’ War, and five years after the boy king, Louis, had succeeded his father to the throne of France. In 1661 the king appointed the great Colbert his *Contrôleur-Général*, who within a few years instituted the “*Académie des Sciences*,” the “*Académie des Inscriptions et Belles-Lettres*” and the “*Académie d’Architecture.*” He also reformed the “*Académie de Peinture*,” which up to his time had been an association for the cultivation of the arts rather than a school. He moreover established the French school at Rome as an adjunct to the Paris school, and this was the origin of the now much coveted “*Grand Prix de Rome*,” given annually to three or four French students of marked ability, and which enables them to continue their studies for four years (engravers three years) at Rome, at the expense of the state. From the reign of Louis XIV to the revolution, the School of Fine Arts existed without interruption, and during the whole of that period was useful in promoting a practical knowledge of the beautiful.

THE CLOSING OF THE SCHOOL.

In 1793 the wild spirits who controlled the affairs of France arrived at the conclusion that the nation had greater need of guillotines than pictures and statues. In that year the Abbé Gregoire read a report before the convention proposing the suppression of the “*École des Beaux Arts.*” The convention accepted the reporter’s conclusions, and the school was closed. Matters remained in this state for two decades, and it was not until the first years of the restoration had

passed that the usefulness of the school was again fully realized. It should be mentioned, however, that Napoleon had authorized a limited course of art instruction at the expense of the state. Nevertheless it remained for the Bourbons to revise and reorganize the school. This was done by royal decree in 1818. In 1819 Minister Decaze promulgated a statute which placed the institution upon its present broad and comprehensive foundation. It organized the studies, assigned the locality for the building, appointed professors, and placed it under the direction of the "*Académie des Beaux Arts*." Later came Louis Philippe and Louis Napoleon, both of whom were active promoters of the arts and sciences, and each took an especial interest in the improvement and efficiency of the National School of Arts. During their reigns many beneficent measures were adopted. In 1864 the organization reached its culminating point upon the issue of a decree establishing definitely the course of the studies, detaching the school from the "*Académie des Beaux Arts*," and placing it under an independent administration, with a special director at its head.

THE INSTITUTE OF FRANCE.

L'Institut de France, as now constituted, is composed of five academies, viz: the "*Académie Française*," the "*Académie des Inscriptions et Belles-Lettres*," the "*Académie des Sciences*," the "*Académie des Beaux Arts*," and the "*Académie des Sciences Morales et Politiques*." It is acknowledged throughout the world to be a most effective agency for the dissemination of learning. It is not only the center of all that is best in French civilization, but its influence is felt wherever the education and development of the human mind are appreciated. No great achievement is too far off to be beyond its recognition. Its portals are wide open to all the earnest students of the universe. The scientist and the artist receive the same warm welcome from whatever quarter of the globe they may come. The Institute of France is the chief glory of the French nation.

It speaks eloquently for the character of this people that they have so realized the civilizing value of all of the arts, and it is also creditable to their past rulers who, acting upon a proper and intelligent appreciation of national sentiment, inaugurated and caused to be maintained such perfect means for the cultivation of artistic taste.

PROVINCIAL SCHOOLS OF ART.

The leading provincial schools of art which are efficient and thoroughly well organized should be briefly noticed in order to render the exposition of fine art organization in France more complete. These in the alphabetical order of the cities are:

AMIENS.—The Provincial Fine Art School of the city of Amiens. The course of instruction is as follows: (1) Elementary drawing;

(2) modeling; (3) anatomy, applied to fine art; (4) imitation drawing (relievo and nature); (5) mathematics; (6) lineal drawing; (7) drawing classes for young girls; (8) history of art.

BORDEAUX.—Municipal School of Drawing, Painting, and Architecture of the City of Bordeaux: (1) Imitation drawing; (2) figure painting and history; (3) drawing and ornament painting; (4) lineal drawing; (5) perspective; (6) anatomy and physiology applied to the art of drawing; (7) architecture; (8) mathematical and physical science applied to architecture; (9) history of art.

BOURGES.—National School of Fine Arts at Bourges: (1) Lineal and geometrical drawing; (2) architectural drawing, mathematics, construction, and perspective; (3) ornamental designing, figure drawing, and composition; (4) architecture; (5) sculpture; (6) painting; (7) painting and sculpture applied to ceramics; (8) anatomy; (9) history of art.

CALAIS.—School of Decorative and Industrial Art of St. Pierre-les-Calais: (1) The classical study of drawing up to and including the knowledge required to obtain the diploma of capability to teach drawing in the university schools; (2) the study of anatomy; (3) the application of the art of drawing to the different professions and industries; (4) the professional application of all the arts to various purposes.

DIJON.—National School of Fine Arts at Dijon: (1) Drawing (lineal and ornamental) from the rudiments up to and comprising composition; (2) figure drawing and painting; (3) sculpture; (4) architecture; (5) perspective; (6) anatomy; (7) history of art; (8) elementary geometry and descriptive geometry; (9) stereotomy; (10) frame and mechanical tracings; (11) industrial drawing.

LILLE.—Academical schools of the city of Lille: (1) Lineal drawing; (2) drawing of figures and ornaments; (3) drawing of plastic or models; (4) painting and composition; (5) anatomy; (6) perspective; (7) geometry applied to arts and elements of mechanics; (8) elementary architecture; (9) normal teaching of drawing.

LYONS.—The city of Lyons possesses, in addition to a National School of Fine Arts, drawing schools under the direct control of the municipality. At the National School the courses are as follows: (1) The drawing of figures, flowers, up to and including composition; (2) painting; (3) sculpture; (4) architecture; (5) engraving and lithography; (6) anatomy and physiology of forms applied to the fine arts; (7) history of art and the elements of archæology; (8) practical geometry, descriptive geometry, stereotomy, and perspective.

There are seven municipal schools, viz: Five for boys and male adults, one for young girls, and a drawing and painting school for ladies.

MARSEILLES.—The School of Fine Arts at Marseilles: (1) Ele-

mentary drawing of the figure; (2) figure drawing from antique plasters; (3) drawing and modeling from life; (4) sculpture; (5) architecture.

MONTPELLIER.—Provincial School of Fine Arts at Montpellier: (1) Study of the living model for painting and drawing; (2) drawing after the antique in round relieve; (3) elementary figure drawing; (4) sculpture; (5) drawing of ornaments, architectural and industrial drawing; (6) stereotomy; (7) history of art; (8) perspective; (9) anatomy.

NANCY.—Municipal and Provincial School of Fine Arts at Nancy: (1) Lineal drawing and geometry; (2) perspective; (3) elements of architecture; (4) drawing; (5) modeling; (6) comparative anatomy; (7) composition of ornaments; (8) history of art; (9) oil painting; (10) painting in water colors; (11) normal courses for students wishing to learn drawing.

NICE.—National School of Decorative Art at Nice: (1) Lineal and geometrical drawing; (2) surveying; (3) leveling; (4) architecture; (5) construction; (6) mathematics; (7) perspective; (8) stereotomy; (9) anatomy; (10) painting; (11) sculpture.

ROUEN.—Provincial School of Fine Arts at Rouen: (1) Classical study of drawing; (2) painting; (3) sculpture; (4) application of drawing to industry; (5) history of art.

ST. ETIENNE.—Provincial School of Industrial Arts at St. Etienne. The teaching in this school is divided into elementary, middle, and superior drawing. The special courses are: (1) Elementary geometry; (2) descriptive geometry; (3) perspective; (4) anatomy; (5) history of decorative art; (6) physics and chemistry; (7) geometrical drawing.

TURCOING.—Academical (Free) School at Turcoing: (1) Drawing; (2) painting; (3) decorative art; (4) architecture; (5) plastic studies and modeling; (6) history of art.

TOULOUSE.—Municipal School of Fine Arts and Industrial Science at Toulouse. The school of Toulouse is one of the oldest and best organized in France. The city has a celebrated connection with the arts. The first public school for the study of the nude was established in 1726. In 1750 it was made a Royal Academy of Painting, Sculpture, and Architecture, by Louis XV. The National Convention in 1793 suppressed the title of "Royal Academy," but the school remained. The principles on which the instruction is regulated are much the same as they were at the time of the revolution. The school teaches everything appertaining to painting, sculpture, and architecture, and it sends every year its best pupils to continue their studies at the *Ecole des Beaux Arts* in Paris.

VALENCIENNES.—Communal Academy of Drawing, Painting, Sculpture, and Architecture at Valenciennes. The academy proper is composed of the leading artists of the city. At the school in con-

nection with it are taught drawing and modeling, and their application to the different professions and industries. The academy also prepares professors of drawing for the universities and municipal schools.

ALGIERS.

There is an important National School of Fine Arts at Algiers. It teaches: (1) Geometrical lineal drawing and perspective; (2) ornamental drawing, history, and composition of ornaments; (3) figure drawing and anatomy; (4) architecture, mathematics, and construction; (5) painting; (6) sculpture; (7) history of art and archæology; (8) application of drawing to industries.

FRENCH NATIONAL MANUFACTURES.

The French national manufactures—those which are under state control and direction—are intimately associated with the history of art in France. The results which they have achieved are such as any nation might regard with peculiar pride. It is not surprising then that Sèvres porcelain and Gobelins and Beauvais tapestry should have been given a conspicuous place in the Exhibition of 1889. The most important of these fine art manufactures have, after a long period of state protection and an enormous expenditure of public money, been brought to such excellence that it is difficult to conceive how they can be made to reach any higher degree of perfection. Nevertheless the endeavor to attain something still higher is as strong now as it was a hundred years ago. It is an amazing fact that, notwithstanding all the convulsions through which France has passed in modern times, each successive régime has realized the importance of maintaining these manufactures, and that although they are a legacy of the old monarchy they have never been made to suffer by political fanaticism. The following grants figure annually in the French budget: Sèvres, 624,450 francs; les Gobelins, 231,520 francs; Beauvais, 116,350 francs; Mosaics, 25,000 francs. Only a small portion of this money returns to the exchequer from the limited sales which are sanctioned by the Government. All the really important works of art produced at the manufactories are used for decorating public buildings in France, or as the state gifts to the heads of foreign nations, distinguished visitors, and others.

GOBELINS.

The Gobelins manufactory originated in the middle of the fifteenth century, when Jean Gobelins, a dyer of Rheims, settled on the banks of the Bièvre, near Paris, and made a reputation by his dyes. Gobelins' industry became afterward combined with that of tapestry weaving on the spot that he had chosen for his workshop, and there was a considerable establishment here in the seventeenth century

when Louis XIV made it a "Royal Manufactory of Crown Upholstery." In 1667 it was under the direction of the painter Lebrun, and for some years it was used for the manufacture of various furniture. It was closed for a time, and when it was reopened in 1699, the Gobelins and the adjoining Savonnerie only produced tapestries and carpets. The regulations of the Gobelins manufactory have been revised since 1871. The establishment is now composed of a manufactory proper, a school of tapestry, and a dyeing school. The workmen are all trained on the premises. They enter as boys, and go through a long apprenticeship. In connection with the tapestry weaving these workmen may very properly be termed artists.

BEAUVAIS.

The history of the Beauvais manufactory does not go back so far as that of the Gobelins. It was founded in 1667 by Louis Hinart, a tapestry weaver from Paris, and began to flourish ten years later under the direction of Philippe Behagle, a native of Flanders. Like the Gobelins, it subsequently became raised to the rank of a state manufactory. Besides its school of tapestry, it has its drawing school. The important technical distinction between Gobelins and Beauvais tapestry is that the former is high-warp while the latter is low-warp.

SÈVRES.

The history of the Sèvres manufactory is, briefly, as follows: A royal porcelain factory was established at Vincennes in 1740, a previous experiment having been made at St. Cloud at the close of the previous century. In 1756 the royal factory was transferred from Vincennes to Sèvres, where it has since remained. Its general organization is very similar to that of the Gobelins and Beauvais manufactories. In addition to its workshop it has its practical school where the workmen or artists are trained from early youth. Only Frenchmen are employed in the establishment, but foreigners can study in the school if they are properly recommended. It is the custom to choose the regular apprentices from among the children of the workmen, so that the art may be said to descend from father to son. The studies in the primary school last two years, and those in the special school five years. The primary lessons comprise lineal drawing and geometry, ornament drawing, drawing of bas-reliefs, perspective, and elementary lessons in modeling. The special school teaches in addition to advanced geometrical drawing and perspective, the elements of architecture, modeling from living plants, etc., composition and coloring, and the principles of decorative art.

MOSAIC MANUFACTORY.

Although Francis I brought workers in mosaic from Italy into France, he did not found any school for the perpetuation of this art

on French soil. The National Manufactory of Mosaics is of quite recent origin, for it dates only from 1876. One of the chief reasons for its establishment was the restoration of mosaics belonging to the state. There is a school attached to it.

LANDSCAPE PAINTING.

It is probable that no nation has produced so many landscape painters as France, and yet it can not be said that from the time of Claude to the present day there has ever existed, in a broad sense of the term, a school of French landscape painting. Nothing that has occurred of late years lessens the force of this assertion. Each epoch in the art history of the country has produced its series of good landscape masters; but they have passed along in lines rather than by groups, and their individual influence has often died with them. To-day there are two or three recognized leaders, each standing quite as much by himself as any of his predecessors. No two living French landscape painters appear to see nature alike, judging from the distinct manner in which they treat it on canvas. This indicates individuality, but not necessarily individuality in its better sense, for a sameness of purpose is perceptible in nearly every work. The majority of landscapists possess sufficient facility for copying nature correctly to make their works objects of interest, especially when the scenes selected are picturesque; but as a rule they only convey to the minds of others the outside of nature. Their pictures are not generally suggestive, and the deeper sentiments with which grand and lovely scenes inspire those who have vivid imaginations are not often found in the works of the later French landscape painters.

It must be admitted that great judgment is often displayed in the choice of scenes, and that in transferring these to canvas the way in which the mechanics of art are employed leaves little to be desired. The painting is often free and the delineation of rock surfaces, details of trees, mountain forms, sky reflections in water, cloud effects, light and shadow, architectural details, etc., are as true to the reality as possible. But notwithstanding all this excellent *technique*, there is usually something wanting that is undefinable. The realism is perfect; what is lacking is related to the unreal, or rather, the ideal. It is soul that we miss—a subtle something that touches the feelings and takes the reflective mind below the mere surface of things. When this quality is absent we know that the artist has been manufactured. Schools may develop the art instinct, but they can not create it.

The majority of French artists, like those of other nationalities, do not exhibit an exact appreciation of the value of correct aerial perspective, a quality in landscape art which has so much to do with regulating distances, throwing back the horizon line, in a word, giving to a composition the true atmospheric effect of out-

door scenes. It appears to be an essential in art which can not be taught by rules.

The landscapes in the French part of the Exhibition are often thoroughly representative of contemporary work, and are well worthy of consideration on account of their truthful expression of various phases of nature. There are many ambitious and serious paintings which convey to the mind all the ideas of nature which accomplished *technique* is capable of communicating. In several notable instances enough of the ideal is expressed to excite the admiration of the cultivated and critical.

Of the fifty-two living landscape painters represented, Cazin assuredly stands near the first. His works possess the indescribable charm already alluded to. Transparency of color, simplicity of composition, dignity of form, brilliant quality of light and air, these and other essentials are strikingly present in them. He also possesses an apt sense of the picturesque and a rare talent for expressing unity of purpose. His creations never fail to be daintily artistic, but his figures are not generally successful, and his works would be better without them.

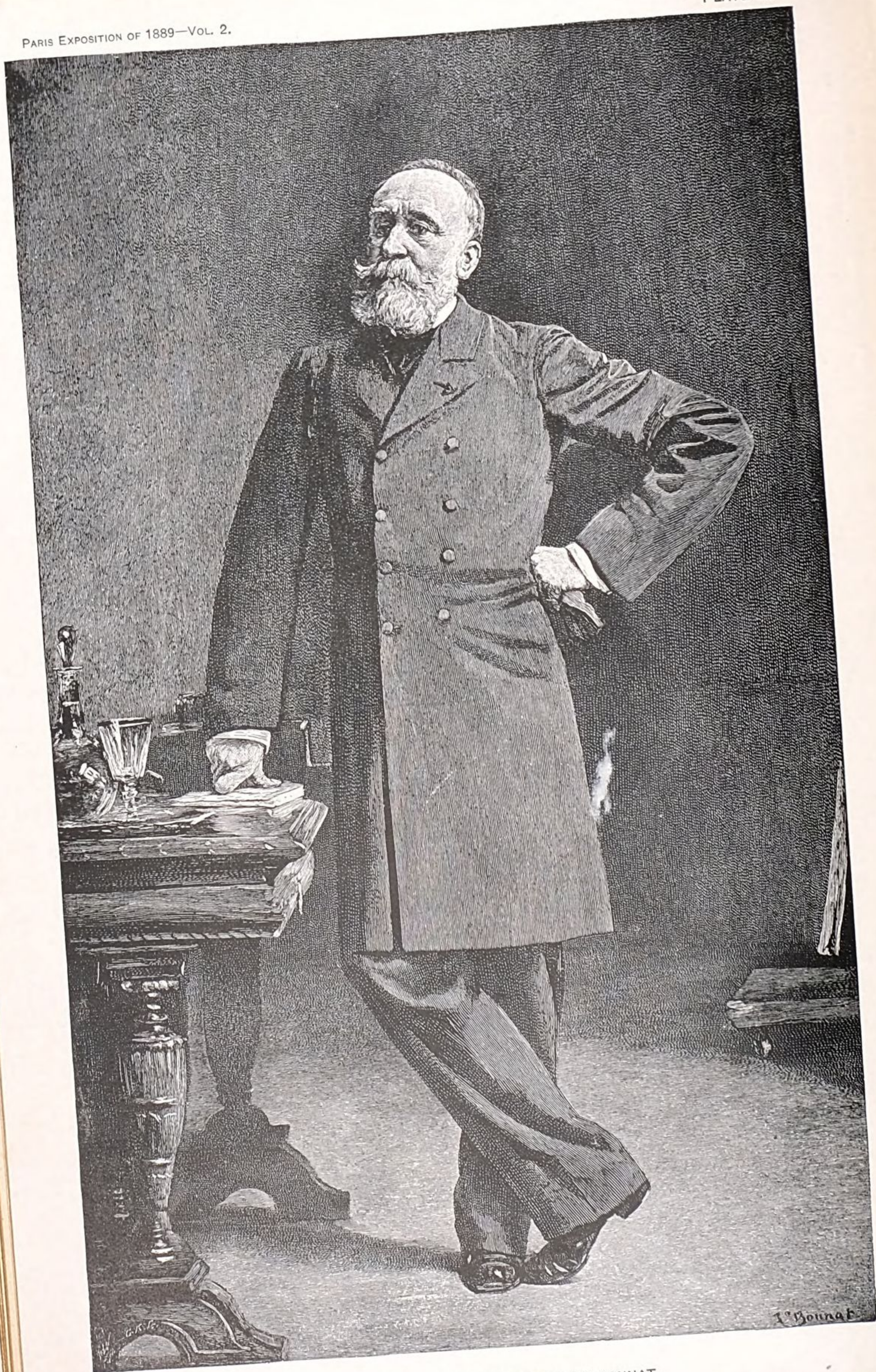
The refined works of Raphael Collin are wonderfully spiritual, and rise far above the bare realities of nature, and are delicate and imaginative to a poetic degree. Harpignies is true to nature, and there is more charm in his skies and atmospheric effects than in those of most of his *confrères*, who are disposed to copy strictly what they see. His trees are most carefully drawn, and express with great fidelity peculiarities of foliage, barks, etc.

Busson is a close copyist of commonplace scenes, which are not usually interesting. The large works of Binet are composed in a serious spirit, and commonly show breadth of treatment, harmony of design, and express somewhat of the poetic. Zuber's works are particularly strong, and well conceived. He never shows a weak canvas, or one that does not fix the attention. Seriousness of purpose, and great technical skill are the chief characteristics of his productions. Heilbuth's pictures are invariably charming. The great master of earthy realism is Pelouse. His painted trees, rocks, shrubs, grasses, and mosses are marvels in their way, and it may be said that no artist has ever carried literal copying from nature to such perfection as he. His imitations are like realities. The directness and wonderful fidelity of his art are entitled to the respect of those who admire honesty of purpose and truthfulness. There are other landscape painters who do good work, but their creations, as a rule, rise only to a moderate standard of merit. Fairly good landscapes, however, have no great value, and for this reason it is not necessary to mention the names of those who paint them.





R. COLLIN 1882



PORTRAIT: PUVIS DE CHAVANNES, BY BONNAT.

PORTRAITURE.

France, like other countries, can not boast of having many artists who produce portraits of great excellence. Of the sixty-two who exhibit specimens of their work during the last ten years, it would be difficult to discover half a dozen who show anything above the uninteresting level of commonplace. The majority of them seem to plod on upon the same old lines which have been followed in all countries for at least the last fifty years. The ordinary portrait shows a well dressed person, whose attitude plainly indicates that he or she has been posed for a "picture." The eyes are always staring the beholder out of countenance; each particular hair, crease of clothing, peculiarity of cravat, ribbon, knot, ruff, tuck, and frill, is represented with the utmost fidelity. All details with regard to chairs, tables, windows, etc., are not less rigidly preserved. It is such stiff and artificial work, turned out by 95 per cent. of the portrait painters of the last half century, that has contributed to enlarge the private art collections of the entire world. Had it not been for the existence of a small number of strong and original workers, portrait painting would long ago have been counted among the dead arts. France to-day possesses at least one such painter, whose work is free from all tricks of trade. It is faithful to the great object and end of portrait painting, which is the pictorial reproduction of the individual in his everyday mood, the one that more fully expresses all that distinguishes that person from all others. It is the faculty of transferring the ruling characteristics of the individual to canvas that proves the greatness of the artist. Durer and Holbein stand very prominently among the great masters who possessed the talent of catching the natural average expression, and the character of the individual with it. The French artist of to-day who has that faculty to a much greater degree than any other among his countrymen is Bonnat. If his portraits at the Exhibition prove one thing more than another, it is that he paints the moral and intellectual, as well as the physical. Of the nine he exhibits, the wonderful portrait of Puvis de Chavannes stands out conspicuously by its many excellencies. It will for all time hold its own as one of the best examples of portraiture which this century has produced. Color, pose, drawing, and expression tell the story of the man just as he is, naught extenuated nor set down in frivolity; but the true man, in all his honesty, frankness, and well-bred charming simplicity of manner, is placed upon the canvas. Here we have the distinguished artist from every point of view. The portrait of Victor Hugo shows the same directness and intelligence of purpose. Not less remarkable is the charmingly composed portrait of Pasteur and his little niece, wherein we see the scientific benefactor of the human race with his protecting arm over helpless and confiding childhood. Here again the face

plainly reveals the refined and benevolent character of the studious man, who is devoting his life to the grand ideal of improving the condition of his kind. Between the portraits of Hugo and Pasteur there hangs, in all the ostentation of the rich colors and ample folds of ecclesiastical vestments, the portrait of Cardinal Lavigerie. Again we see the character of the man, or rather the man-created official of the creator. His position in the chair where he sits, and his facial expression bespeak the ecclesiastic, proud in authority—a single cog of a wheel is the most earthy of all earthy machines. A portrait bust of the younger Dumas is quite as remarkable for its many fine qualities as the other works mentioned. It would be superfluous to attempt further description of the works of this great artist. They now assert their rightful position in the history of contemporary art, and assuredly will stand the test of time.

Gervex, in his portrait of Alfred Stevens, shows a fine feeling for simplicity in composition and directness of aim. His large canvas of the members of the Salon Jury of Painters, is a most interesting collection of portraits, and it brings the life and movement of a well-known yearly scene vividly before the spectator. The grouping is natural and excellent. Roll, in his portraits of Alphand and Demoye, both done with a free hand, displays rare facility of execution and a most happy conception of the true end of portrait painting. Dupain contributes a good specimen of his faithfully elaborated and ornate work. His portrait of Admiral Mouchev is one of the best examples of this particular kind of art in the whole Exhibition. A portrait of Edmond de Goncourt, by Raffaelli, is exceedingly lifelike and striking. The color has a certain chalkiness, which some artists would call “snappy.” The work is strongly composed, but it goes a little too near the crudities of the Impressionists to be pleasing to the eye, and the whole scheme of color suggests *post-mortem* conditions.

But the ultraimpressionist portraits of the Exhibition are those of two ladies by Besnard. They fairly out-Herod Herod, and effectually put into the background the lower toned works of Manet. In the luridness of their prismatic color they are far enough away from nature to represent supernatural objects. Is not their effectiveness, of which there can be no doubt, merely affectation? Such work may represent the art of the future. But let us hope, however, that this future is still very far off.

Carolus-Duran exhibits eight portraits. One, “Mme. la Comtesse V.” is a dignified, earnest work, strong in color. The pose of the figure is natural, and the likeness is probably a faithful one. This portrait must be regarded as one of his best of the present time. The others are only performances of his average merit. They show fine technical work in the painting of stuffs, and skill in posing and the graceful arrangement of the draperies, but they are rather disap-

pointing, and do not seem to reach the standard which we have a right to expect from the brush of so good an artist.

There are two portraits by Meissonnier, one of a young lady and the other of himself. The latter is dated 1889, and is one of the latest works from his easel. It is so new and original in its treatment, that it stands quite by itself. The costume is suggestive of a priest's *soutane*; but the color is of light terra cotta, and the garment opens and fastens down the front. The head, costume, and the surroundings suggest the period of the *Renaissance* vividly, so well is the ancient style portrayed, and the likeness is a faithful one. The pose is dignified, easy, and natural. No doubt the artist painted this portrait with the idea that it would be the one by which he would be known in the future. None could answer that purpose better.

FIGURE PAINTING.

Of the compositions exhibited whose claim to merit rests chiefly upon the study of the human figure there is much to be said, and more to praise than in condemnation. The professional critic, who writes so knowingly and with such an air of absolute authority, consigning with a scratch of the pen to his own particular oblivion, a work that may have cost its creator months and perhaps years of patient labor, knows practically nothing of the great difficulties involved in the production upon canvas of an acceptable representation of the human form. It is, of all the great essentials in art, the one for which the ambitious painter has the most frequent use, and is at the same time the most difficult to master, and unless he can present it in a fairly truthful way, his compositions, wherein the human figure occurs, although they may possess certain elements of success, can not be acceptable to those capable of discriminating the false from the true.

To a certain point of mechanical correctness only is about as far as the average modern figure painter ever gets. We may take academic correctness as the present standard, and admit those who have reached it to be worthy of consideration. The writer feels that the exquisite grace which Raphael knew how to portray, and the grandeur of the male human form which Michael Angelo painted are no longer attainable. If such is the case, we must take the best we have and make the most of it, nor bestow wholesale condemnation upon earnest workers because they can not reach the highest standards raised by the greatest artists of all time.

Prominent among the figure painters of the present day is Benjamin Constant, who exhibits ten works, seven of which, in his well-known style of coloring, are full of his individuality, and are not by any possibility to be mistaken for those of any other artist. The work of this painter may not be of the highest order, but it is at

least his own, and is not to be easily imitated. The other compositions are decorative pieces, occupying three panels, and intended for the council hall of the Sorbonne. They are entitled "Les Lettres," "L'Académie de Paris," "Les Sciences." These are in the purely decorative style now in vogue, both as regards color and composition, and are quite worthy of the position they are destined to occupy.

Jean Beraud is another among the representative painters who have created something new, which may be called their own. His most important work, among the four exhibited, is entitled "A la Salle Graffard." It represents a meeting of Anarchists who wish to reform the world down to their own level. The scene is exciting and is vividly portrayed. The expressions of the leaders' faces are such that the work might be described as a conference of the Infernals. The artist seems to have painted without exaggeration an actual scene.

P. Albert Besnard is more than half way on the road to the Impressionist goal. The great difference between his work and that of other Impressionists is this, that his is full of original suggestion; but at its best it is not far removed from the drop curtain of a spectacular drama, painted by one of the better scenic artists. This kind of painting is like a certain kind of so-called music, it needs explanation.

A. William Bouguereau contributes ten works, the most important as to size and the number of figures in the composition being "*Jeunesse de Bacchus*." The scheme of color is that which has come to be associated with this artist. The women are pale pink, the men dark brown. The drawing of the figures is (academically) remarkably good; that of the man in the foreground being especially strong. The work shows throughout the evidence of Greek culture; and although there is a great deal of correct nudity in it, and the subject lends itself to voluptuous treatment, there is no impure suggestion. Refinement is one of the ruling qualities of M. Bouguereau's works, but it is apt to become insipid. His next important subject is "*Jésus Christ rencontre sa mère*." The Christ is conventional; the mother is outlined with academical correctness; but the picture leaves no impression of creative thought. Of the other eight pictures, several are very beautiful from their soft harmony of color and purity of line. The works of this artist, although they are so devoid of the emotional, have an undeniable charm that appeals to many. They are probably destined to occupy a prominent place in the history of French art of the nineteenth century.

M. Jules Breton is a painter of the French peasant. He has given the world a greater variety of truthful pictures of the peasants' everyday life than any other artist. He has represented his rustics as rather intelligent beings, not half idiotic, in the manner of Millet. We see them in every phase of their habitual existence,

but they are always men and women who seem to enter upon their labors, devotions, and amusements like the rest of humanity. If the art of this painter has exercised any influence upon those who have contemplated his works, it has been to raise the peasant in their estimation; while Millet's rustics may excite pity in the breasts of a few, the brutality and coarseness of the types disgust the majority. Among the works by Jules Breton contributed to this Exhibition is to be seen the sketch of "*Le soir dans les hameaux du Finistère*," which the writer regards as his most artistic composition. The others bear the stamp of an earnest and intelligent worker, who has labored in a field open to all, and who has made it in some respects peculiarly his own; but in his later works there seems to be a falling off from the strength of his former days.

Pascal A. J. Dagnan-Bouveret has received the highest recompense at the Paris Salon of 1889, and also the medal of honor from the International Art Jury of the Exhibition. It has been said of him that he is the coming man, but if the obtaining of two of the highest official recognitions for his work in one year signifies anything, he has already come. His work, like those of nearly all the great masters, is remarkable for solidity, careful drawing, and great attention to detail. It is as far off from the Impressionist methods as daylight is from darkness, and offers not the slightest indication of that supposed *abandon* which painters of questionable knowledge often have recourse to for the purpose of producing a sort of slapdash effect, which tickles the appetite of the inexperienced buyer, and which the dealer knows how to turn to account. His work, which received the first prize at the salon, is in every respect most carefully executed. The grouping of the figures is picturesque, and the pose of each is natural and unconstrained. The lines of the drapery are easy, and the textures are correctly painted, but not overwrought, so as to make them an ostentatious feature. Sky, landscape, and atmosphere are painted with skill betraying perfect knowledge of values. The whole composition is conservative, and one may search in vain for a single touch of the brush that was not made with an intelligent purpose. The sterling worth of the picture grows upon the mind, and in this respect contrasts strongly with the acres of canvas which bear evidence of "boldness of handling and strong effects of color," in other words, effect of paint, but of nothing beyond. Of M. Dagnan-Bouveret's five pictures at the Exhibition, his "*Pardon*" in Brittany is the most noteworthy.

Of the six works exhibited by Edouard Detaille, "*Le Rêve*" is the most important as to size and subject. It represents a regiment of infantry bivouacked in line of battle with arms stacked. The sleeping soldiers are dreaming of the glories of arms, for in the sky above them is shown a phantom multitude of men bearing arms and flags. The painting is crude, and does not do justice to the artist. His

other important work which commands attention is his "*Cossagues de l'Ataman*." Here we have a regiment of Cossacks on the march. The work is animated, and the column being strung out through the middle distance certainly gives a fair idea of mounted troops in movement; but it is not so good as many of the artist's earlier paintings. The remaining four are also military pieces.

Edouard M. G. Dubufe exhibits four works; two of them large and important, "*Musique Sacrée et Musique Profane*," diptych, were in the Salon of 1882. These are pleasing and graceful compositions in transparent colors and of a most decorative character, and may be regarded as illustrations of the beautiful in the thoroughly academic style of contemporary art. In the first, angels are singing to the accompaniment of the organ, and in the second groups of nude women in graceful attitudes, are listening to the sensuous strains of a pipe played by a youth. The two works are as opposite in general treatment as possible, but are unmistakably expressive of the ideas intended to be represented. As pictorial efforts they are notable, and among the most attractive in the Exhibition.

Ernest Duez is represented by nine works showing considerable variety of effort. A portrait of the artist Butin, and a small landscape, are the most pleasing of his contributions. The "*Portrait rouge*" does the artist no credit. It is as commonplace as the ordinary illustration in a society novel, and its color is most aggressive. Another work, "*En famille*," is less offensive in color, but it is conventional, and might have been painted by an artist of inferior ability. This painter, like some others, is particularly mentioned here, less on account of the works he has sent to the Exhibition than because of his well-earned reputation.

Henri Gervex is one of the strongest, boldest, and perhaps the most original among the later French artists. He covers a considerable field in the world of art, and is equally proficient in several departments. His most successful work, composed entirely of portraits, is mentioned elsewhere, but his most startling composition occupies the central place among his nine canvases exhibited, and notwithstanding its peculiarly suggestive character, it justly commands attention. The title of this work is "*Rolla*," and it depicts a bedroom scene with two figures in it. There is a young woman upon a bed, clothed with flesh tints only, and a man is standing between the bed and a window, evidently puzzled as to what to do—whether to stay or jump out of the window. The composition is the incarnation of deviltry and boldness, the color is brilliant, the whole consummately artistic, and undoubtedly immoral in sentiment. Another of this artist's creations is "*La Femme au Masque*," a nude woman wearing a little black mask over the upper part of the face. The figure is very gracefully drawn and delicately painted, and altogether the picture is treated with such skill and charm that one

does not care to reflect upon the taste shown in the choice of such a subject.

Jean Jacques Henner is represented by eight works; three of his portraits might be colored photographs. Besides these are the well-known pretty head in a red hood, a Christ on the Cross, two of the artist's usual examples of the nude, and a St. Sebastian. The two religious works are interesting, intelligent, and well-executed compositions that do not fall into M. Henner's ordinary groove.

Jean Paul Laurens is the least known in the United States of all the notable French artists of the day. His position among his *confrères* is that of the learned student of history and the accomplished painter of serious subjects. With the exception of a portrait now and then, he confines himself to out of the way but interesting incidents. He has the rare faculty of always engaging the attention of those who look at his works. He regards the pursuit of art as an educational occupation, especially as an aid to those who delight in historical research. Two of his works at the Exhibition, "*L'Agitateur du Languedoc*," and "*Le Pape et l'Inquisition*," may be taken as fine examples of his painting both as regards picturesque composition and choice of subjects.

S. B. Lavastre is represented by a single work, "*Frise autour du Dôme Central, au Champ de Mars*." It is the composition of a thoroughly educated artist, and is moreover remarkable for the warmth and mellowness of its color, and taken as a whole is one of the great works of this period.

Léon A. Lhermite exhibits two works, "*Le Moisson*" and "*Le Vin*." The first is a harvest scene, and the second is the interior of a wine shed, with workmen resting. Both are as realistic as possible, and show no attempt at the picturesque. The men—the principal figures in each picture—are giants, wonderfully drawn. These paintings tell nothing save the bare truth, but they tell it strongly.

Albert Maignan is a notable student and a painter whose field is that of historical incidents. His canvases, like those of Laurens, are always interesting. He never chooses a trifling subject, nor trifles with it when chosen. His works convey the idea of serious endeavor. Of his eight pictures in the Exhibition "*La Voix du Tocsin*" is the most remarkable. It tells the story of one of the functions of a church bell. The subject is treated with a vigor of conception and a freedom of physical action seldom equaled. The effect is produced without any exaggeration of the means. Figures seem to have been thrown into the air from the mouth of the bell; and although unsupported, appear to be in their element; others are hanging to the ropes, and they likewise seem to be in their proper places. One is disposed to accept these spirits of the bell as actual entities, so strongly does the imagination of the artist enter into the work. It is a graphic poem upon canvas.

Victor Marec is a painter of rare power, who shows a fine discrimination in the choice of subjects. His three contributions to the Exhibition are most creditable compositions. They do not commend themselves to the crowd, but they appeal to those who look below the surface of a canvas for the deeper significance of the artist's intentions. "*Un lendemain de pays*" tells pathetically and graphically the old, sad story of the helpless, patient wife resigned to her fate, with her frightened children clinging to her for protection, and the brutal, drink-saturated husband in the act of raising a chair to deal the possibly fatal blow. The story of degradation and abject poverty is completely told. Nothing is wanting to convey the cruel lesson belonging to an everyday incident of low life. Can art be put to a better use than that of telling the fortunate their duty towards the unfortunate? Is not the artist who produces a work of this sort a real benefactor to his kind?

J. L. Ernest Meissonier commenced his remarkable career more than fifty years ago; and within the period of the active practice of his calling he has justly achieved the widest artistic reputation of our later times. At the commencement, he marked out the path he intended to follow, and pursued it with singleness of aim until he compelled the universal recognition of his success. Those who are capable of judging, and who know his works, can attest his wonderful skill and truthfulness of execution, and appreciate the difficulties he overcame in producing one of the least important of his carefully wrought compositions. In the absolute perfection of his details, such as the painting of stuffs, leather, metals, feathers, furniture, etc., he has had few, if any, equals. The importance of all these little essentials which go to make a perfect whole is, in his works, never undervalued. Meissonier is also a master of the anatomy of the human figure, and the delineation of facial expression. Whether he depicts the happy repose of the smoker, the vigilant look of the soldier on guard, or the angry and excited movements of men engaged in a quarrel, the expression and action are always natural and suited to the scene. It is greatly to his credit that amid all the temptations by which he has been surrounded he has never deviated from his original direct course, and painted merely for effect. His works have ever been characterized by earnestness of purpose and honest methods. He has always been a believer in solidity of painting and careful drawing; constructing intelligently with a view to preserving natural relations; ever seeking simplicity of composition as the highest and noblest attribute of art. Now that he has reached the autumn of his days he has the satisfaction of knowing that honesty of purpose and incessant labor are rewarded with a reputation which rests upon a solid foundation. His fame will stand the test of time; and the luster of his record can not be eclipsed, no matter who may come after him. Moreover, the honors which he has already

received have not been empty ones, for there has been bestowed upon him the most remarkable series of official recognitions ever awarded to an artist; and the financial appreciation which has flowed in upon him in a steady stream is without precedent. His ten paintings in the competitive part of the Exhibition, which stand as specimens of his last eleven years' work, excepting two, show that the vision of the artist is as clear and his touch as firm as ever. "*Le Voyageur*" and the "*Postillon revenant haut le pied*," both executed since 1883, are replete with the fine qualities of this artist's better work; and, in the belief of the writer, the former must ever rank as one of his greatest productions.

Aimé Morot is an emphatic expressionist. In telling his stories he leaves no doubt as to his real intentions. His enormous canvas "*Reichoffen*," which depicts the famous charge of MacMahon's Eighth and Ninth Cuirassiers, is the largest in the Exhibition, and is a work of undoubted merit. It has the grand rush, which nearly all the pictures of charging cavalry lack. Although the horses in the front rank of the charging column may be flying through the air instead of running at full speed upon the earth, the great effect to be sought for is there. The go, the rattle, the clang of war, are on the canvas as, perhaps, they have never been on any other. "*Le bon Samaritain*," is a work quite opposite in character. In this nothing is done for effect, but a plain story is simply and truthfully told. The Samaritan, his donkey, and his suffering charge, form one of the most completely satisfactory and finely executed groups in the Exhibition. The two human figures will bear the closest critical scrutiny. The drawing betrays an unusual knowledge of the human anatomy.

Puvis de Chavannes, one of the most imaginative of the later French painters, does not exhibit, but reference is made in the catalogue to several of his well-known works, his grand decorative composition, "*Pro Patriâ ludus*," now in the Amiens Museum, heading the list.

Of J. François Raffaëlli who has a persistent set of outspoken admirers, it may be safely said, that he has the faculty of seeing clearly and describing sharply, so as to leave no doubt as to his intentions. But there is a great difference of opinion as to his general scheme of color. Doubtless in many instances his coloring is forced and unnatural; he is nevertheless a master of strong expression, and shows originality and facility in drawing.

Alfred Roll is one of the most thoroughly distinctive of the younger French artists. His ten works exhibited display a very wide range of accomplishment, and establish conclusively his right to a position among the foremost painters of his time. His "*La fête de Silène*" is very typical of his strongly expressive work. It shows a jovial old Silenus mounted on his ass, surrounded by attendant nymphs,

and in his very best mood. "*La grève des Mineurs*," and "*Le Travail—Chantier de Suresnes*," are strikingly realistic. The scenes are depicted with great directness and strength of purpose, but it is doubtful if the subjects are worthy of the valuable labor bestowed upon them. Three others, "*Femme et Taureau*," "*En Normandie*," and "*Manda Lamétrie, fermière*," are pastoral poems on canvas. They are all pitched in the same charming key of tender color, and are specially attractive by their fanciful, and at the same time truthful, expression of the simplest realities.

Joseph Wencker, together with his seven portraits, displays two important compositions of another kind. The larger of the two, "*Prédication de St. Jean Chrysostem contre l'Impératrice Eudoxie*," is spirited and picturesquely composed. It is an historical work of more than ordinary interest. It tells its story so plainly that the dullest may understand it.

From Cormon, Delacroix, Faivre, Jamin, and Nemoz, we have a group of works representing imaginary scenes appertaining to the everyday life of the stone age. These show great originality, are skillfully executed, and are sure to interest all who are in search of the extremely curious.

Among other living French artists exhibiting interesting works—very skillfully treated in many instances—may be mentioned the names of Barrias, Bloch, Bordes, Boutigny, Bramtot, Brouillet, Carrière, Chartran, Chigot, Clairin, Dawant, Delahaye, Dubois, Ferrier, Friant, Geoffroy, Giacomotti, Gilbert, Giradot, Humbert, Jean-Nicot, Krug, Lagarde, Le Blant, Lefebvre, Le Poittevin, Lesur, Maillard, Merson, Montenard, Moreau de Tours, Perrandau, Perret, Rochegrosse, Roy, Saintpierre, Tissot, and Weerts.

WATER COLORS AND PASTELS.

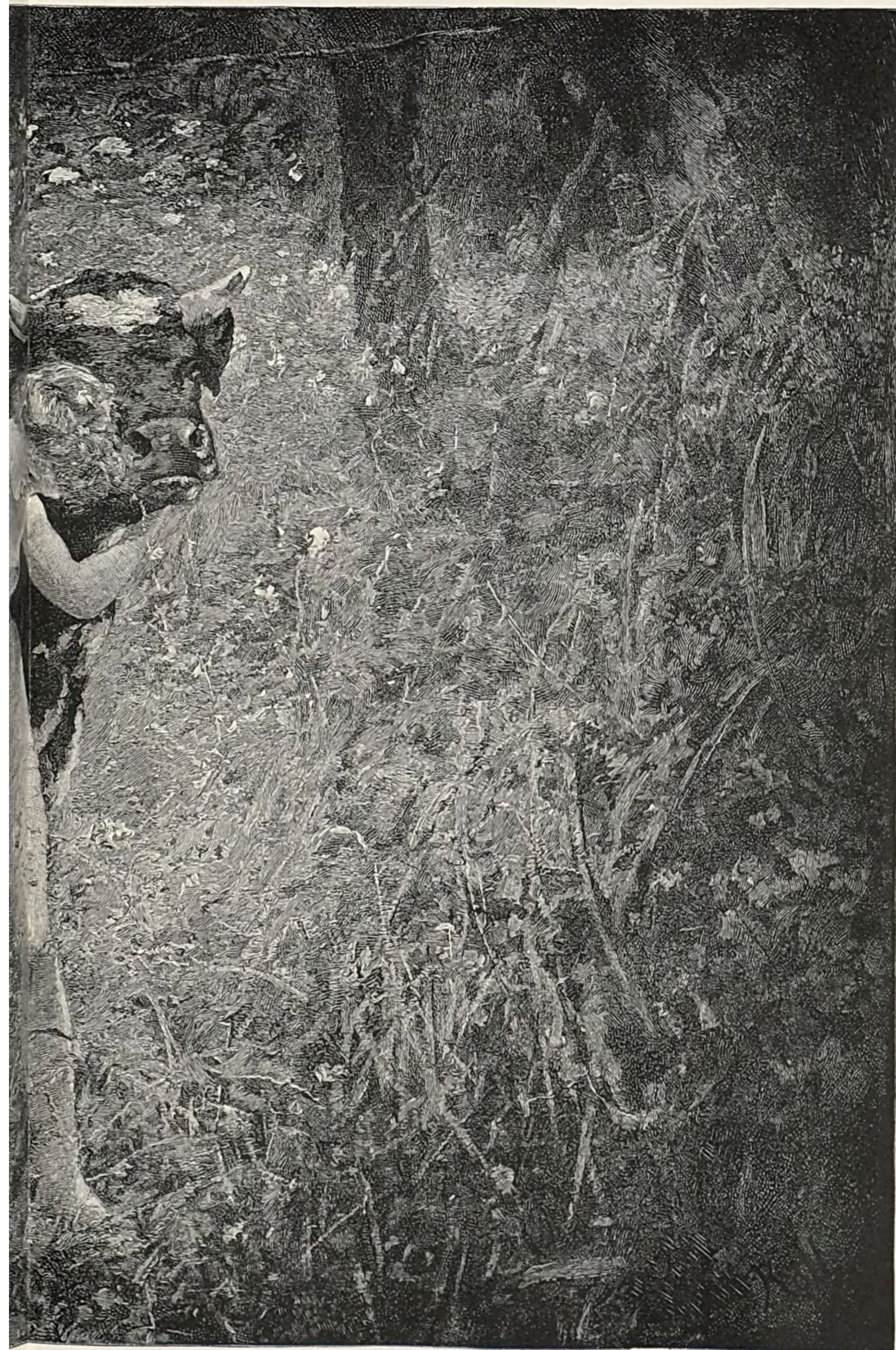
The collection of two hundred and fourteen water colors, pastels, miniatures, and various drawings in the competitive part of the French section, is not remarkable for artistic work. There are very few pieces worthy of special notice. Standing out conspicuously among these are the six pastels by J. Charles Cazin. They show his usual facility for original composition, and much delicacy of touch. Among others of exceptional merit may be mentioned those of Bida, Doucet, and Renouard, and after these Allonge, Bayard, Gagnairt, Carrier, Belleuse, Eliot, Mme. Guyon, Iwill, Mlle. Pompey, Raffaelli, and Rivoire.

SCULPTURE.

From the time of Donatello—the point of departure from the stiff and unnatural Gothic sculpture—no modern nation has possessed at any period of its history a more remarkable group of great sculptors than is to be found in France at this time. Much of their stat-

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uary displays the grace of pose, the beauty of outline, and vigor of execution that we find in the works of the great Greek masters. For boldness and originality of conception, some of their statues stand unrivaled in our later times. These sculptors are not the outgrowth of any school or system of teaching, for their works bear no flavor of the academy. They are individual and independent, and in the simplicity and directness of their conceptions we see the achievement of masters. Very noticeable, too, in their work, is the absence of any attempt at trifling with nature, so as to produce cheap effects which please the vulgar eye. Such qualities denote the true greatness that comes from earnestness. The writer regrets that he can do no more than briefly notice in this report a few of the more prominent among the French sculptors whose works were to be found at the Exhibition.

M. L. E. Albert Lefevre contributes six pieces. This artist has the faculty of expressing sentiment, but is often uncertain in his execution. His statue of "*Adolescence*" is that of a young girl standing in a simple pose, her arms raised to her head, and looking dreamily into the future. It is beautifully modeled, is exquisite in sentiment, and gracefully posed. Several of the sculptor's other works are interesting, but they can not be compared to this one.

Paul Aubé's statue of Bailly is perhaps the best costumed figure in the Exhibition. It is that of a man standing simply and firmly, holding in his left hand the formula of the famous oath of the "*Jeu de paume*," while his right hand is raised. The gesture is solemn, and the entire figure is full of dignity. Other works of this sculptor are marked by the same simplicity and strength.

Alfred Boucher is the artist of a notable group, "*Au but*," a foot race. Three naked runners are nearing the goal with outstretched hands, every line of the faces expressing anxiety, and the figures the utmost physical exertion. This group represents a great effort, and is as far from the conventional as possible. There is, however, sameness of expression and action in the figures, but the idea of movement is conveyed with singular vigor.

Auguste Cain appears to be as nearly the successor of Barye, as we can expect any sculptor to be. He is dramatic in sentiment and movement, but he does not attain to the combined simplicity and vigor so admirable in Barye's works. He never seems to perfectly understand the character of the animal he represents. His "*Rhinocéros attaqué par des tigres*," and his "*Lion terrassant un crocodile*," both bronze groups, are imposing and interesting; and were it not for the recollection of the artist's great predecessor, they might be regarded as triumphs of sculpture in relation to the brute creation.

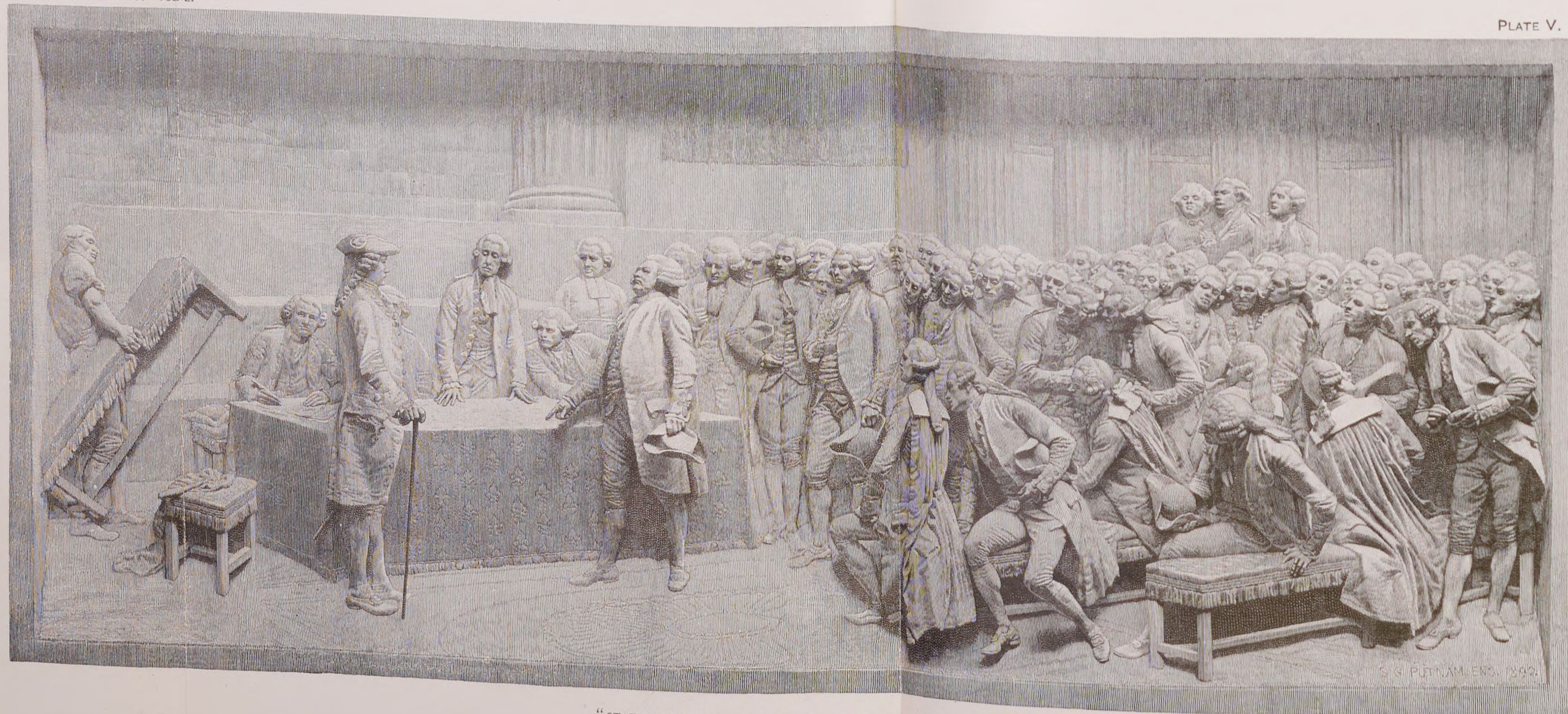
Jules Dalou exhibits two very large high reliefs and several busts. All are strong, bold in execution, and indicate extensive knowledge

as well as talent. His great masterpiece illustrates a famous scene at the commencement of the French Revolution at a meeting of the *États Généraux*. The King, after delivering his speech, left the hall, followed by the nobles and part of the clergy. The other deputies were ordered to leave. The Marquis de Brèze, master of ceremonies, entering, asked Bailly, the president, if he had heard the King's command, and received the never-to-be-forgotten answer from Mirabeau, "Go and tell your master we are here by the power of the people, and will only be dismissed by the power of bayonets." The work is worthy the great and patriotic event it represents. The illusion as to depth, and great masses of men is perfect, and there is wonderful variety in expression and attitude. Some are calmly taking in the situation, others, more or less excited, are talking among themselves. The work is as natural as it is energetic. In the whole composition there is but one exaggeration; the figure of Mirabeau is somewhat theatrical, rather than dramatic. Nevertheless the story is forcibly told; and we have here one of the finest high reliefs in existence, and possibly the greatest ever modeled by the hand of man.

Paul Dubois is the accomplished director of the *École des Beaux Arts*. In addition to his reputation for scholarship in connection with the fine arts, he is regarded as a fine portrait painter and a good sculptor. He is influenced by the Italian Renaissance, has no great originality, but he sees the details of nature and executes his works in a spirit of refinement. He has contributed to the Exhibition four sitting statues to be placed at the angles of the monument to General Lamoricière in the Cathedral at Nantes. These are "*La Charité*," a woman with two infants on her knees, charming in sentiment and composition; "*La Foi*," a young girl, with hands clasped and face raised in prayer, very expressive of religious fervor; "*Le courage militaire*," and "*L'Etude*." The two last, like the others, are carefully executed with due reference to correct expression. Little bits of drapery and other details minutely worked do not, however, suggest grandeur or strength. The artist's other statues, "*Le Chanteur Florentin*," and "*Eve naissante*," are more in the style wherein this sculptor is seen at his best.

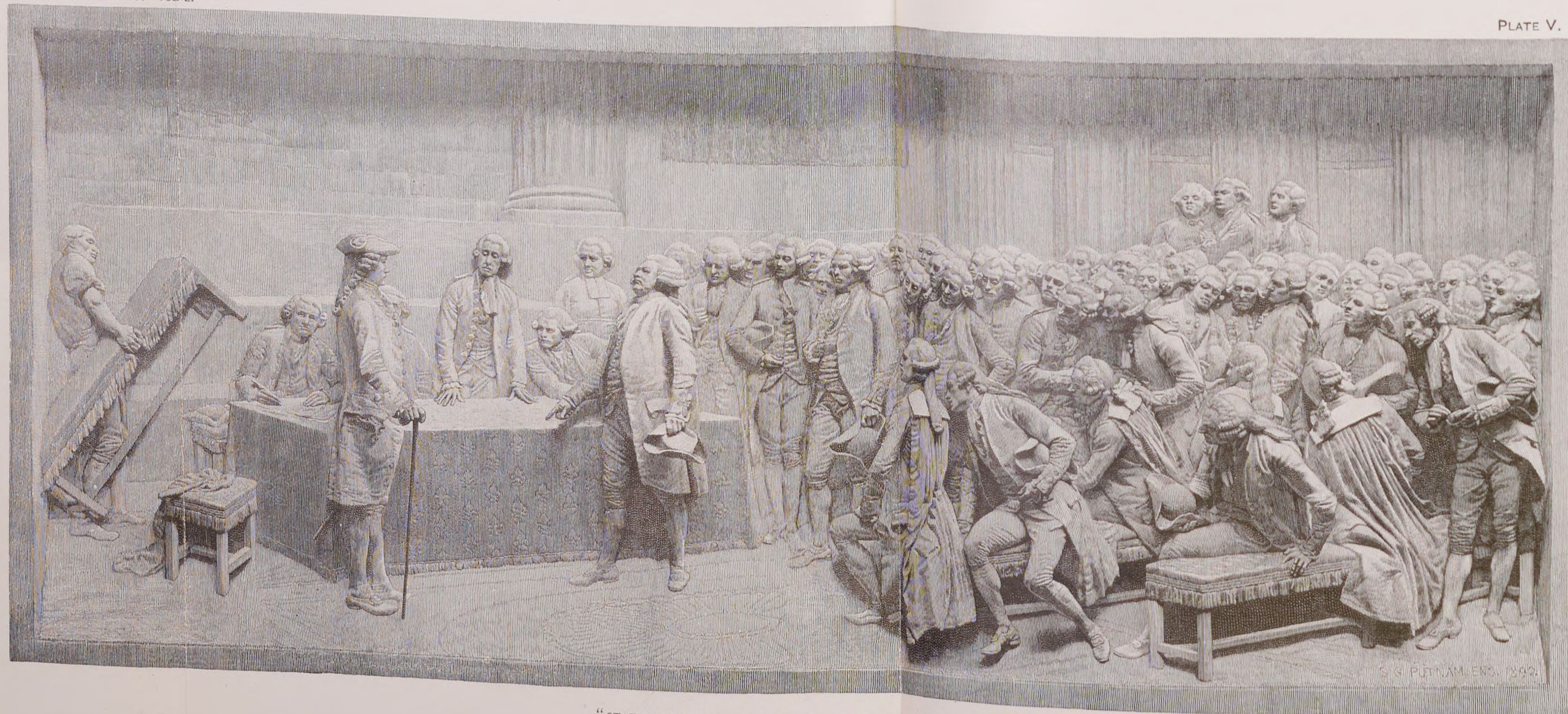
Léon Fagel has scored a success with his statue of Chevreul, the centenarian scientist, dressed in the unpicturesque costume of to-day. The head is very lifelike, and the whole composition is easy and natural. The sculptor's five other contributions show skill but not greatness.

It has been said of J. A. J. Falguière that he is a sculptor of fine artistic instinct, but that the enthusiasm of his southern nature causes him to be indifferent to certain aspects of his work, and very unequal. He does what pleases him, without caring whether it pleases others or not. His "*Un vainqueur au combat de Coqs*" is a

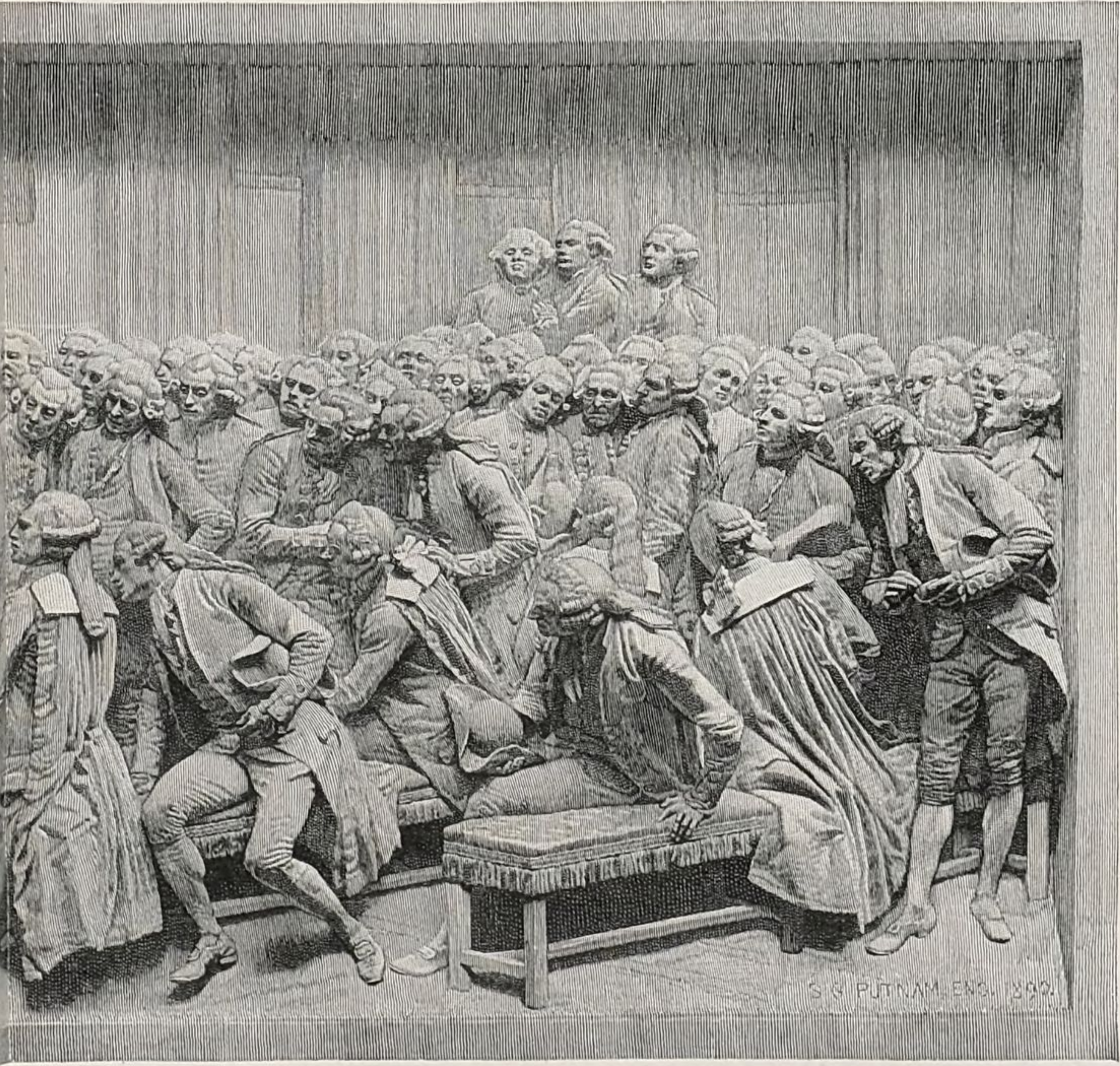


"STATES GENERAL;" SITTING OF 23^d OF JUNE, 1789: BY DALON.

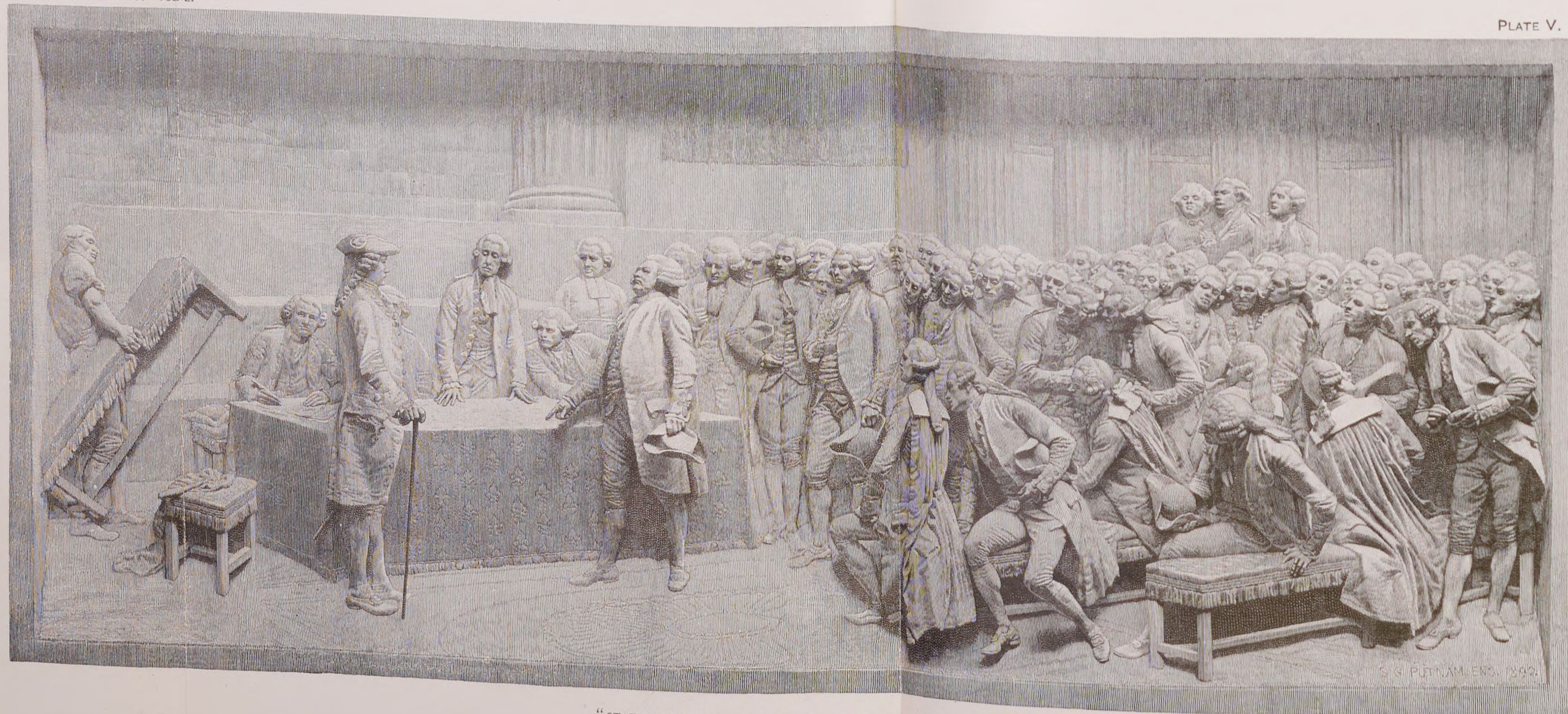




"STATES GENERAL;" SITTING OF 23^d OF JUNE, 1789: BY DALON.



1789: BY DALON.



"STATES GENERAL;" SITTING OF 23^d OF JUNE, 1789: BY DALON.

PLATE V.



1789: BY DALON.



GORILLA AND WOMAN, BY FREMIET.



THE NYMPH ECHO, BY GAUDEZ.

young boy holding with his right arm a victorious game-cock, and snapping his fingers with delight. It is a little masterpiece, beautifully modeled, and finely expressive of the high spirits of youth. The other piece exhibited, "*Tarcisius, Martyr Chrétien*," is a figure of a young martyr who has been stoned to death, and who is pressing to his breast the Christian emblem. The work is very touching in sentiment.

Emmanuel Fremiet is one of the greatest of living French sculptors. His individuality is strongly impressed upon his work; every piece may be said to bear the sign manual of the man. His terribly repulsive but wonderfully vigorous group of a gorilla carrying off a struggling woman limp and half crushed in its powerful grasp, and holding a stone in one hand to throw at the pursuer, is a marvel of exciting realism. No description can give the least conception of the strength of this composition. The contrast that it presents of physical weakness and power is admirable. In every line the beast is the brute of brutes. The whole presents a terrible vision and, possibly, not much of an exaggeration of the lowest side of human nature. It shows the masterly touch in the manipulation of masses and details, and is most artistically composed. This group is a partial repetition of one that figured in the Exhibition of 1860. In that the gorilla was seen dragging his victim instead of carrying her. It was considered so shocking by the Salon Jury that they refused it, but the Minister of Fine Arts gave it a separate room at the Exhibition of that year. Another of his famous groups now exhibiting, "*Le Denicheur d'Ourrons*," represents the struggle of an old hunter with a she bear that has caught him in the act of carrying off her young. The contest is to the death, the knife is doing its fatal work, and so are the strong arms of the enraged mother. This composition is fierce and full of agony. In another striking group by Fremiet, "*L'Ours et l'homme à l'âge de Pierre*," we see an almost naked savage holding in his hands the head of a bear that he has just overcome, and wildly dancing in the excitement of his triumph. Although this is purely a work of the imagination, it seems to revive an epoch in the unrecorded history of man. There is an intense movement in the works of this artist, which renders them even more lifelike than those of Barye. He is the sculptor of all living forms, and his works are unparalleled for intensity of movement. The sculptural construction, the bones, the extremes of natural action, are perfectly understood and rendered. All of his work is carried to the highest point of comprehensiveness; when it is delicate it surpasses nature, when beastly most brutal, yet not vulgar, and when vigorous nothing can be more so. He is one of the few artists of these days who have produced thoroughly good equestrian statues, which can be compared to the best of the Italian Renaissance.

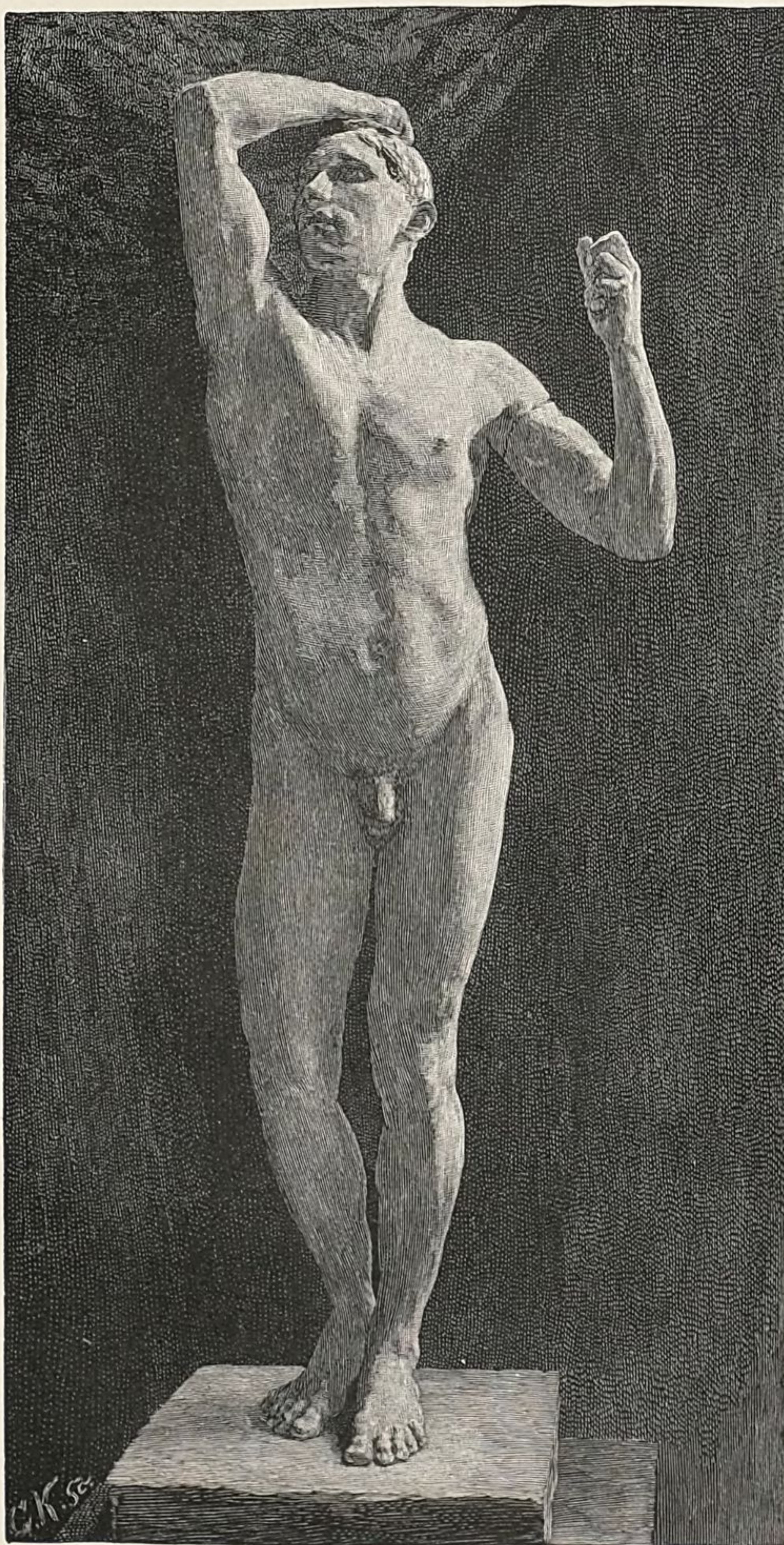
Adrien Gaudiez contributes two statues, "*La nymphe Echo*," and

"*Parmentier*;" both are strong works, but the former is the most beautiful female statue in the Exhibition. The girlish but well developed form exquisitely feminine and full of simple grace. It is a genuine work of art, free from all affectation. In all the productions of this talented artist are to be observed a fine appreciation of simplicity and an honest purpose to aim only at natural effects.

Claude G. B. E. Guillaume is a learned academician who produces work of an absolutely peculiar kind, which pleases the multitude. The most representative among his ten exhibits is the "*Mariage Romain*," a group of two figures in marble. It is formal to an extreme degree, and stands more for art than nature, and may be regarded as an inoffensive example of purely academic work.

Antonin Mercie is represented by five pieces. His work generally is very pleasing. "*Le Souvenir*" (a figure for a tomb) is in many respects charming, but lacks the grandeur and spirit that would stamp it as the work of a great artist. His "*Quand Môme*," a woman in modern Alsatian costume, taking the gun from the hands of a dying soldier to defend her country, is marked by a fine spirit, but the general effect is greatly marred by superabundance of detail.

The five works of that wonderful artist, Auguste Rodin, stamp him as one of the greatest sculptors of modern times. He unlocks the secrets hidden in the human form, and applies them to the noblest and grandest uses of art. He also knows the human mind, and is a master of its most subtle expressions and manifestations. It may be said of him that he never busies himself about trifles. His work is always suggestive of more than is seen, and compels serious consideration. Where the Greeks excelled he also excels, and among moderns the greatest of them all, Michael Angelo alone, has surpassed him in the originality of his conceptions. While he understands the Greeks so well he is no imitator of them. He sees nature with his own eyes and works out his impressions in his own way. The secret of Rodin's success may be explained by the high development in him of the art instinct, his extensive knowledge of the literature of art, his disregard of commercial considerations, his fixed determination to avoid littleness in execution, and to accomplish his results by the simplest means. Of the five works he exhibits, "*L'Age d'airain*" is the most complete embodiment of his style. It is a nude figure of a young man, his arms uplifted, one hand pressing his head, the other clenched, expressing pain. No words can describe the beauty of its simple lines, or the intensity of the expression portrayed. It is so strong, delicate, and natural in its construction that there seems to be nothing omitted save the power to move. This work, however, was not a success in the Salon of 1877, and, but for a few discriminating artists who admired it, it would have been refused. It was accepted, but was placed in an out-of-the-way corner, and the sculptor was accused of having *cast it from*



THE ARYAN AGE, BY RODIN.

nature. Twelve years have passed since then, and now, in the great Exhibition of the World's Art, it is admitted to be one of the astonishing masterpieces of modern times. In 1884, another fine work by Rodin was refused at the salon, and he was accused of having cast it from some old Greek statue. His later busts of Hugo, Dalou, and Proust are true works of art; better than mere portraits, they reveal something of the inner character of the men they represent, and, like his other productions, show masterly handling. His finest work, and surely the most grandly and solemnly impressive of our later times, is his group of "*Bourgeois de Calais*." It illustrates an historical incident; that of the leading citizens of Calais appearing before the English conqueror in answer to his summons, with ropes round their necks, in order to save the town from pillage and destruction. This is a truly noble work, lofty in conception, and most impressively treated.

Réné de Saint-Marceaux contributes four interesting pieces. "*L'Arlequin*" is a small statue excellent in pose, skillfully finished, and very expressive of gay and mischievous humor.

Of the works of Jean Turcan, "*L'Aveugle et le Paralytique*," a marble group, is the most important. It represents a blind man, directed in his path by a paralytic whom he is carrying on his back. Without being a work of genius, this may be regarded as very good sculpture. It is unconventional, and has other virtues; the torso of the blind man, for instance, is beautifully modeled, and the whole composition is interesting by its novelty and evident sincerity of purpose.

Among sculptors who appear in the French section, but are not mentioned in the foregoing remarks, are many whose work in other countries would be rightly regarded as far superior to that of those mechanical mud-pilers who have fashioned most of the commemorative statuary that is supposed to adorn modern cities of the world.

ENGRAVINGS.

It would be beyond the intent and scope of this report to attempt anything like a just and comprehensive notice of the excellent work to be found among the four hundred and forty-four productions by French engravers, exhibited under the head of "*Gravures et Lithographies*." The collection is as interesting and artistic of its kind as any other in the exhibition. It moreover makes us realize that the greatest engravers of to-day are equal to the best of those in the past. Among the finest examples shown may be mentioned a portrait, after Van Dyck, by Charles Baude; the "*Parting Day*," after Leader, by Brunet Debaines; the "*Chocolate Girl*," after Liotard, by F. Eugène Burney; the "*Minuet*," after Jacquet, by F. Eugène Champollion; the "*Storm*," after Diaz, by Theophile Chaurel; Dar-

win, after John Collier, by Léopold Flameng; nine wood engravings, after drawings by Rochegrosse, Raffaelli, Renouard, and Richmond, by Mlle. Marie Genty; the "*Drawing Master*," after Meissonier, by Achille Jacquet; the "*Gunsmith*," after Fortuny, by C. Louis Kratké; "*Miss Fanny and Dog*," after Seymour, by Adolphe Lalauze; the "*Meeting of the States General, June 23, 1789*," after Dalou, by Alphonse Lamotte; three wood engravings of scenes around Paris, after drawings by the engraver, Louis A. Lepère; the "*Man at the Window*," after Meissonier, by Paul E. LeRat; a bust of Dalou, after Rodin, by H. Auguste Leveille; the "*Souvenir*," after Chaplin, by Stephane Pannemacker. Charles A. Waltner is represented by many fine examples of his work, and there are contributions by other artists of merit.

FRENCH COLONIES.

A small number of exhibits from Algeria and other French colonies brings us to the close of the competitive part of the French section. These colonial works do not appear to be of sufficient importance to call for special mention. The art sections of other nations will now be considered in the order in which they occur in the official catalogue.

GERMANY.

That country was not represented by many works of its best men, but artists of German nationality residing in various parts of Europe, contribute one hundred and one exhibits to the Exhibition. Among these were to be found several which in conception, scheme of color and general treatment, stand quite by themselves. They are toned after the manner of some of the strong colorists of the Venetian and Dutch schools, figures and faces being carefully painted so as to express national, rather than personal, characteristics.

GERMAN PAINTERS.

Albert Keller, of Munich, has a fairly good and interesting portrait of a lady, and also a study of the nude. Gotthardt Keuhl, who lives in Paris, has six works, all interiors, neither French nor German in treatment. They are *legers* as to color, subject, and composition, but are not offensive, and are calculated to please the majority of fairly cultivated people, who believe they admire the arts and like pictures of a story-telling order.

Wilhelm Leibl, of Rosenheim, Bavaria, contributes six works. Three of them, "*Femmes de Dachau*," "*Vieux Paysan et jeune fille*," and "*Paysanne de Vorarlberg et enfant*," are notable for the qualities mentioned at the head of this notice. They are strong character works, and the subjects of them could never be mistaken for other

than Bavarian peasants. The face of the old man in the second work named is quite repulsive, but is undoubtedly an extremely truthful portrait of a low type of Bavarian slave of the shovel. The face of the young girl is expressive of innocence and characteristic of a nationality.

Max Liebermann, of Berlin, exhibits six works, all fairly good, and thoroughly representative of himself. The "*Cour de la Maison des Invalides à Amsterdam*" and "*Cour de la Maison des Orphelines à Amsterdam*" are the most important. In each the figures are numerous, carefully painted, and naturally grouped, the whole presenting truthfully everyday scenes, without any attempt at the picturesque. The works of this artist are highly esteemed in Germany.

Charles Meyer, of Munich, has three interesting pictures, which, however, are not so well painted as they are composed. "*Le fumeur*," a man in an old costume smoking, is conventional. The deep, warm tone shows the influence of bygone colorists upon the artist. "*Le conte mystérieux*" is a group of old men sitting round a table, eagerly listening to the thrilling story of one of the party. The picture is well composed, and were it not for some defects of color it would be an interesting work.

Hansolde, of Teekamp, Schleswig-Holstein, has sent two paintings, "*Allant à l'Eglise*" and "*Le Matin*," both creditable, and the former particularly interesting.

Friedrich Karl von Uhde, of Munich, has contributed two works, his "*Last Supper*" ("*La Cène*") being regarded as one of considerable importance. Perhaps the reputation of the artist has had something to do with this. To the writer, however, the work seems crude, and painted with little regard to supposed facts and probabilities. The entire group is composed of men whose types might be found on the wharf of any city of northern Europe. There is not a face among them that bears the least indication of Semitic origin, nor do their expressions and gestures betray those qualities of mind which are reasonably attributed to the nearest friends and disciples of Christ. The composition is without dignity, and fails totally to give an adequate idea of the solemnity of the great scene which it is supposed to represent. "*La petite Emilie*" is a simpler but better work. The subject is a young peasant girl coming through a rough stubble field, painted in the realistic manner of to-day. It is a matter-of-fact peasant portrait that answers the aim of the realist, but suggests nothing.

ETCHINGS.

Karl Koepping is represented by two etchings, "*Les Syndics des Drapiers*" and the portrait of an old man. Both are after works by Rembrandt, and the technical skill shown in them reflects the utmost credit upon the artist. The writer can conceive of nothing finer

and broader in the way of etchings than these reproductions of works by the greatest Dutch master. They must be reckoned among the most remarkable examples in existence of the art of drawing upon copper with *aqua fortis*.

The majority of the works in the German section do not rise above mediocrity. It is not difficult to perceive that in them the commercial aim predominates.

AUSTRIA-HUNGARY.

Austria and Hungary are represented in all classes of the art section by one hundred and fifty-nine exhibits. Probably, for the reason that Austria is one of the non-recognizing governments, the collection does not show forth in a comprehensive sense the present condition of art in that country. It nevertheless contains several artistic and notable works quite worthy of special mention.

AUSTRIAN AND HUNGARIAN PAINTERS.

Vacslav Brozik has five paintings, one of which, "*La défenestration de Prague*," is a very large and ambitious composition. The historical event that it is intended to depict was an act of violence that led to the Thirty Years' War. The imperial councilors, together with their secretary, are being thrown out of a window, because of their refusal to subscribe to the demands of the justly enraged Protestants headed by the Count of Thurn. One of the councilors, the central figure, is struggling with those who have seized him, and his movements, and the expression of his face, betray such abject cowardice as to destroy the entire dignity of the composition, and to render it ridiculous. Much better than this is the artist's unpretentious canvas, "*Le Retour des Champs*," which, as a cattle piece, is at least inoffensive. His other three works are of no particular interest.

Blaise Bukovac exhibits six paintings, not one of which is of great value. "*Le printemps de la vie*" is, however, a pleasing composition, expressive of the subject, and delicate in color.

Edouard Charlemont is represented by thirteen works. Three are portraits, not above the average. "*Les Pages*" is a large, carefully painted canvas, showing a very earnest attempt to accomplish something of value; but the complete want of texture and the color hardness have rendered the attempt futile. The nine others are small figure pieces, hard, unsympathetic, and as regards execution, false in every essential.

Adolphe Hirschel, in one of his two exhibits, gives a glimpse of the past at Rome in the year 590. This work is not an entire success, but it contains bits of careful painting of old marbles, which render it of great interest to those who admire elaborate and painstaking art.

Albert Hynais in five of his works displays considerable facility for purely decorative composition. His figures are often graceful, the arrangement of his groups effective, and the high light tones of color are just what is required for decorative purposes. His two portraits are without interest.

Jan Matejko has covered an enormous canvas with a great deal of paint. It is among the largest of the exhibition, and is entitled "*Kosciusko après la bataille de Raclavice.*" It is a most diffuse composition, conceived without definite ideas as to centralization of effect, spotty in color, and does not realize the grandeur of a great historical scene.

Michel de Munkacsy has a world-wide reputation, and is regarded by many persons as one of the great artists of the day. His "*Christ before Pilate*" and his "*Christ at Calvary*," which reappear at this Exhibition, are so well known that no description of them is necessary here. They are most ambitious works, and must have cost the artist a world of thought and labor. They are serious, large in execution, and are earnest efforts in a great direction. In the opinion of the writer they are in every respect the best achievements of this artist.

Jules de Prayer is represented by three large works, depicting scenes connected with the sad fate of Sir John Franklin and his companions in the Arctic regions. They suggest the solemnity of that awful history more vividly than has ever been done before.

Rudolph Ribarz is an artist who is generally correct in his outdoor effects. He is a close follower of nature, throws his individuality into what he does, and has the rare faculty of making an interesting picture from an uninteresting subject. Of his ten contributions the one entitled, "*Overschie ; Holland*,"—a marine piece, with boats, and buildings on the shore, is the most important.

Vacslav Sochor is represented by two works: "*Procession de la Fête-Dieu en Bohème*," and a portrait. In the former, a gaudy, commonplace scene of a Catholic country, is treated in a conventional spirit. It is glaringly offensive in color, and is altogether inferior to the better theatrical scene painting. Unfortunately its enormous size brings it prominently into notice.

Othon de Thoren, a well-known painter of cattle pieces, a member of the International Jury, died within three days after the work of judging was completed. His seven contributions are thoroughly representative of his life's work. Several are exceedingly tender in color, and show a good understanding of perspective, and the picturesque in composition. While the works of this artist may not be regarded as great, they are much nearer the truth, and more pleasing than those of many others who have greater reputations.

BELGIUM.

The Kingdom of Belgium is represented by four hundred and fifty exhibits, of which two hundred and fifty-two are oil paintings. Among the latter are several of marked merit, and the collection, taken as a whole, reflects great credit upon the Belgian artists. The influence of contemporary French art upon them is easily recognizable, but only in few instances, so far as this collection is concerned, can it be said to have been detrimental to them. The truth is, that the stronger among the Belgian artists possess the necessary power and the faculty of asserting themselves.

BELGIAN PAINTERS.

Emile Claus has three charming landscapes, very characteristic of his manner. They are true to nature, and are marked by much tender sentiment. The "*Passage d'Eau*," a daintily painted piece, is the most highly elaborated of the three, and is such a work as an admirer of the simple and beautiful must perforce appreciate.

Franz Courtens, who, in the belief of the writer, is one of the greatest living landscape artists, is represented by five works. The strong points with him are his deep feeling for nature, his intimate familiarity with its best pictorial phases, and a fine instinct that enables him to apply them to higher purposes of art. His knowledge of technical resources enables him to derive the fullest value from his rare power of selection. Although he never has recourse to slapdash to produce his effects, which bear the stamp of careful, solid, and honest work, they are boldly and broadly conveyed. His perspective is just, the horizon line is placed where it belongs in nature, and when a bit of architecture or shipping is introduced, the drawing and texture are faultless. His most important work among those now exhibited is "*Le retour de l'office*," but the most charming are "*La pluie d'or*" and "*Le barque à Moules*." Together they give a good idea of the better qualities of that artist.

Emile Delpérée has sent a most ambitious picture; "*Martin Luther à la Diète de Worms*." It is an earnest attempt to adequately commemorate one of the most important events in the history of civilization, but it is only a partial success. It is somewhat theatrical rather than dramatic as the artist intended.

Jean Pierre Lamorinière has three works of considerable merit. They are of marked individuality, and are worthy of the artist, who is greatly esteemed in his own country; but to the writer they appear to be only careful studies of trees and topography for studio use.

Robert Mols displays a very long canvas entitled "*Rade d'Anvers*." It is in fact the water front of Antwerp. It has the merit of veracity, and is strictly panoramic.

Alfred Stevens is perhaps better known out of Belgium than any

other Belgian artist. He contributes to this Exhibition seventeen pictures. They show great fertility of resource, facility for rapid production, and leave upon the beholder an impression that there are plenty more of the same sort where those came from.

Alexandre Struys has sent only two works, but each bears the signs by which we know a man of sentiment and an earnest artist. "*Le gagne pain*" is a scene of everyday life—an interior with a peasant mother giving medicine to a son who is ill. It is a very simple story wonderfully told. The other, entitled "*Mort*," is sternly pathetic. A dead man is lying in his coffin and a woman is upon her knees. This is the whole subject, but it is thrillingly interpreted. The artist possesses singular power in dealing with human emotions.

Jan van Beers exhibits his painting of the yacht, the rowboat, the waiting crew, and the conventional yachtsman, handing down the stairs, presumably into the boat, the young lady in correct attire. Besides this he shows thirteen other trifles, all in his usual style, save one little landscape belonging to the Comtesse de Flandre, which is charming, being simple in subject and truly artistic in execution.

Jan Verhas is represented by four important works of strong individuality. They could never be mistaken for those of another man. One that stands out prominently is "*La revue des écoles*"—the children of Brussels passing in front of the King. This is a masterly character-work that brings Belgium generally before the spectator, and Brussels in particular. The whole scene is as natural as possible. The first rank of children—beautiful little girls—are not French, German, or Dutch, but distinctly Belgians, and so it is with the rest. The type is clearly set forth. The atmosphere, the sky, the town are there, and the exact perspective renders the architectural effect perfect. The writer once heard an artist call this a mechanical picture. Its mechanics are such as the majority of artists would do well to master. The other three works are not large, but they are perfectly representative.

Theodore Verstraete is another of the good Belgian landscape painters. He exhibits four pieces. "*Le lever de lune à la Bruyère*," contains in the foreground some charming work, but fails in aerial perspective. "*Soirée de Novembre*" seems more satisfactory, and reminds one a little of the better landscapes of Millet.

Alfred Verwee is an artist of considerable individuality, and he has sent four works. He paints cattle pictures, but by no means of the sort to which we are most accustomed. His art is virile. His productions are not always true to nature, but he never trifles. In some of his paintings he shows peculiar aptitude for conveying an idea of the grandeur of great space.

Emile Wauters, another of the esteemed Belgian painters is represented by twelve works, nine of which are portraits. "*Cosme*

Somzée" a boy on horseback with a dog holding a whip, is a large ambitious composition, and so is another portrait, that of the boy's mother. Both rise far above mediocrity in portraiture. To the writer, however, the artist's Eastern scenes appear to be his most successful works. Their composition and *technique* are good, and they have the local color of Egyptian life.

There are other Belgian artists who are not considered to be in the first rank, but several of whom produce acceptable works; among these last may be named Artan, Asselberghs, Mlle. Beernaert, Bouvir, Broerman, Mme. Collart, D'Anethan, Dedans, De la Hoese, Den Duyts, De Smeth, Mlle. De Vign, Dierick, Ronner, (Alice), Simons, Smits, Stallaert, Stobbaerts, Zytgadt, Van Biesbroeck, Vanderecht, Van Havermaet, Van Hove, Verhaert, and Vanhayden.

BELGIAN SCULPTORS.

After the French the Belgian sculpture is the best in the Exhibition. The strongest men have originality, and much of their better work shows that they are influenced by the study of the Gothic. In the productions of others we find a reflection of the commonplace and handskill of the poorer French workmen.

Guillaume Charlier has three works, all refined in sentiment and forcible in execution. His large composition "*La Justice inspirée par le Droit et la Clémence*," is impressive but rather sketchy. His kneeling statue of a young girl, "*Figure tombale*," is charming in sentiment and pose. His busts are also interesting.

Paul de Vigne is a powerful sculptor in expression, dignity, and strength. His monumental group "*Breidel et De Coninc*" erected in Bruges to the glory of the victors of the battle of Courtrai, fought in 1302, is large and grand in composition and execution; worthy of the great event it commemorates. The three busts by this artist are wonderfully fine. They are studies for heads of figures in his large monuments. For simplicity of handling and expression they are without rivals in the whole Exposition.

Constantin Meunier tells in marble and bronze sad stories of the everyday life of the lowly. "*Le Grison*" is an episode of coal-mining. A mother finds her son among the dead, after an explosion; and the pain expressed in her face as she gazes at the corpse is human, natural, and peculiarly touching. The composition is simple, something after the manner of the early Italians. By the originality of the artist a great effect is produced in combination with perfect repose. There is no trace of exaggerated physical action. Here we have proof of ability of a high order. This sculptor's "*Puddleur*" is of the same kind of art, and tells in awful lines the terrible tale of degradation in the mines. What an expression of low brutality it conveys. In treatment it is like the other; simple, direct and true. These works are surely the outcome of humane

impulses in an artist who feels what he does, and it is not his fault if they do not teach a great lesson to the wealthy and thoughtless.

Pierre Charles Vanderstoppen's work conveys the idea of personality, but is somewhat pretentious. "*L'homme à l'épée*," a young man holding a sword, is a good figure, but a little stiff in pose. "*Le taciturne*," an old Flemish nobleman, has a character of its own, and conveys to the beholder an idea of nobility. It is certainly one of the good statues of the Exhibition. His "*Saint Michel*" is a man in armor; simple in composition, decorative, and quite mediæval in effect. His other works are fine, but artistically inferior to those mentioned.

There are some good pieces by Braecke, Mignon, and Namur, but not to be compared with the work of those sculptors whose exhibits have been described.

DENMARK.

Of the two hundred and forty-eight works contributed by Denmark one hundred and ninety are oil paintings; and this is about all that can be said of them. To call the majority of these "works of art" would be to make a very reckless use of a term that has been already sufficiently abused. As a rule, they are unsymmetrical, unimaginative, unsentimental, and commonplace as regards subject and composition, while in technical qualities they are rough and uncouth. There are not twenty among them which show that the artist who painted them possessed a sense of the beautiful. Possibly the works of these Danish painters prove that they possess qualities which, among certain artists and writers, pass for boldness, breadth, and strong brush-work. But the presence of all of these virtues combined in a painter does not compensate for the absence of the picturesque.

DANISH PAINTERS.

Michael Ancher, a painter of unaccountable inequality, exhibits eight works. His "*Se tirera-t-il d'affaire?*" a group of fishermen looking out to sea, is a fine composition, well executed, and plainly indicates an artist of talent. His "*Portrait de ma femme*" is also a good work, but his "*Vieillard devant sa maison*" is unworthy of the slightest commendation. The old man is of the very lowest type of humanity, and the whole composition has the qualities of an exceedingly bad chromo. The artist's other paintings are not good, but they are better than this one.

Otto Bache exhibits a portrait rather above the average, and a large picture of two work horses. These are rather well painted, but the work is not artistically composed, nor is it even interesting.

Peter Severin Kroyer, of Copenhagen, contributes seven works, among which is the best in the whole Danish collection. This is "*Le Comité de l'Exposition Française à Copenhagen en 1888.*" It

is a large interior filled with portraits of Frenchmen, principally the more elderly and better known among living artists. It is well conceived, the portraits are done with a free hand, the postures are natural, and the grouping is well arranged. It is, beyond all cavil, a very successful work, and of a kind very difficult to treat successfully. This artist also exhibits a portrait of the director of the Academy of Fine Arts at Copenhagen, which is dignified and possesses character. His other works on view are not remarkable for artistic qualities.

L. Tuxen contributes five canvases. Among them is a good portrait of Mme. O. Jacobsen, very simple and direct in treatment. A remarkable specimen of realism is his "*Italienne sortant du bain.*" It can not be described, but must be seen to be appreciated. His other exhibits are not very noteworthy.

Among other artists whose works are fairly good may be mentioned Mme. Ancher, Brendekilde, Hammershøj, Henningsen, Jendorff, Johansen, Mols, Niss, Paulsen, N. K. Skovgaard, Therkildsen, Wegmann, and Zahrtmann. The drawings in black and white by Hans Tegner are original, full of character, and very picturesquely composed.

SPAIN.

The artists of Spain are represented by one hundred and seventy-nine pieces, one hundred and sixteen of which are oil paintings. This collection contains more large canvases in proportion to its numbers than any other in the Exhibition. Its appearance is consequently somewhat imposing, but in the matter of artistic worth it can not be compared to the Spanish collection in the Exhibition of 1878. The present section suffers from the absence of Zamacois' works, and the charming pictures by the gifted and lamented Fortuny. Nor can anything be found in it equal to the "*Jean de la Folle,*" by Pradilla. It is in vain that one looks for good works to supply the place of other fine productions that can be called to mind; moreover, the fact must be recorded that several of the artists whose work we admired eleven years ago do not appear to advantage now.

SPANISH PAINTERS.

Luis Alvarez, the painter of romantic pictures displaying gaily dressed men and women, brilliant stuffs and furniture wonderfully elaborated, has left his old paths and given his attention to subjects of a more serious character. He has sent to this Exhibition a very large canvas, "*La chaise de Philippe II; Escorial, 1597.*" This work represents one of the most horrible characters known in history, sitting upon a seat hewn out of the solid rock, to which he has just been carried. He is pictured in consultation with a minister, probably over the perpetration of some fresh act of cruelty or injus-

tice. The composition has been intelligently conceived, and seriously and artistically treated.

José J. Aranda contributes five works, among which is a Crucifixion, unrefined in treatment and failing utterly to convey the picture of that appalling event. His "*Les Politiciens*" is conventional, like scores of other works dealing with subjects of the same order. What we see in this, as in others, is an animated but commonplace dispute, that leaves the spectator indifferent. The remaining works are in no way superior to those which have been named.

The late José Casado del Alisal is represented by a marvel of all that is horrible, "*La Cloche de Huesca*." A middle-aged man with a large, remarkably savage-looking dog, is in a cellar or dungeon, where the wholesale decapitation of human beings has taken place. The floor is strewn with heads, and red with blood. To make the horror still more horrible, there is a blood-dripping head hanging from a rope in the middle of this gruesome subterranean chamber. This terrible scene is wonderfully and faithfully elaborated upon a very large canvas. The work is one of enormous power, but in a fearful direction.

Antonio Gisbert presents another tale of blood, "*Exécution des Torrijos et de leurs compagnons, Malaga, 1831*." The band of patriots are undergoing military execution. A group of dead bodies is in front of a line of men waiting their turn; others, a second rank, who are to form the next line for execution, are being blindfolded. This is also a large canvas, and the scene is extremely revolting.

Felix Resurreccion Hidalgo has sent a canvas of imposing size. "*L'Enfer de Dante*," very confused and very infernal.

Louis Jimenez has contributed a work of a very different character from those already mentioned. This is "*Une Salle d'hôpital; la visite*." An emaciated young girl is sitting up in bed, in an ordinary hospital ward, having her lungs examined by a physician. Other physicians and students are standing near awaiting the result. A sad, everyday story is pathetically and humanly told, with sincerity free from affectation. It moves the beholder to sympathize with suffering.

Raimundo de Madrazo has relinquished the painting of ideal subjects and become a painter of portraits of the *beau monde*. They seem to flow from his palette in a continuous stream, but they are hard, cold, unsympathetic, and formal, and convey no idea of the character of those whom they represent. Imagine a large canvas, say, 6 by 4 feet, covered with a deep body of color, in imitation of the dark "Sèvres blue," and upon this the full-length figure of a woman in a dress of the well-known pink of the Sèvres rose teacup, the whole executed as though it were painted upon porcelain and baked, and we have a typical example of the present work of this artist. His figures, however, are all well dressed, and usually appear

as if they belonged to the upper dead-level of society respectability. In these portraits the effects flowing from a combination of light and shade are never seen, and a sameness in values pervades the whole.

José Carbonero Moreno has given us a very large canvas, "*Le duc de Gandiá devant le cadavre de l'Impératrice Isabelle*." Here we have a dead woman in a coffin at one end of the picture, a group of standing figures at the other end, and the man who is holding the up-turned lid of the coffin pressing suggestively a handkerchief against his nose. The whole is well composed and correctly painted, but the picture excites no interest, and leaves the spectator unmoved and in doubt as to the purpose.

Francisco Pradilla's large work, "*Reddition de Grenade*," is an exceedingly florid military painting, of accomplished *technique*, and carefully treated generally. It can not be compared, however, to the great work by which that artist was represented in 1878. It is overcrowded with figures, which were not necessary to the success of the composition.

Martin Rico, who is so popular with the dealers and picture buyers of the United States, is now represented by seven works, all brilliantly white and sparkingly green. Of course they are said to be crisp, and possessed of "fine atmospheric effect," but they give us neither nature nor art.

Emilio Francis y Sala shows a large and forcible composition, "*Expulsion des Juifs d'Espagne*." There is considerable skill in the execution, but it does not tell its story in plain terms. An explanation should have been printed in the catalogue. This artist's "*Etude de Fruits*" is better than the usual conventional fruit painting.

DRAWINGS.

Armand Jiminez, whose oil paintings have been mentioned, appears to great advantage in his drawings and one water-color. They are original and strong, and show a refined appreciation of nature.

Daniel Urrabieta Vierge is, in the opinion of the writer, the greatest Spanish artist living. Certainly, in his peculiar way in the use of pen and ink, he stands unrivaled. His works prove that he has no sympathy with the empty pretensions, charlatanism, and vices of the day, and no folly flies without being pierced by his arrow. The great range of his imagination and his keen perceptions make him a master in the delineation of human passions and weaknesses. Whether he portrays the vain frump, garbed in a thin wash of austerity on her way to her devotions, the dishonest beggar with his artificial expression of suppliant misery, the driving of a bargain, the Jew in pursuit of money, the vanities of the successful grocer's wife, the supersanctimonious posings of the sleek prelate, or the proud and

overbearing demeanor of the newly made plutocrat, his success in telling his story is always the same. Originality of conception and execution, vitality, force, and vividness of expression, place the works of this artist in the front rank among the best of all times, and it is by no means certain that in his particular line he has ever had his superior.

UNITED STATES.

The exhibits from the United States numbered five hundred and seventy-two, and in quantity came next to the competitive collection of the French, while the fairly good quality of a portion of the work commanded attention and an unexpected amount of appreciation and approval. Several disinterested judges—artists and critics—competent to give intelligent opinions, decided that in merit as well as in magnitude its place was next to the French section. That it did contain a number of well painted, strong, original works is a fact that can not be disputed. It is also true that the collection as a whole was an interesting one, and showed great progress in the several departments of art during the last eleven years.

If we take into consideration the fact that in the French Exhibition of 1878 we had only one hundred and forty-three oils and water-colors and nineteen engravings, making a total of one hundred and sixty-two, and that in the late Exhibition we had more than three and a half times that number, the relative numerical importance of the two collections becomes clearly apparent. It should, moreover, be borne in mind that what has been accomplished by our artists has been done without the aid of their own Government and with little encouragement from their own people. It is a fact that can not be too much insisted upon that American purchasers who pay large prices, generally buy foreign names, whose pictures may or may not be works of art, and that the meritorious productions of their own countrymen, save when found in the hands of the dealer, they usually pass by unheeded.

It may therefore be taken for granted that whatever credit—and the writer claims that it is considerable—this exhibition of art may reflect upon our country, Americans, as a people, deserve none of it. The credit is due to their leading artists alone, who have toiled, often without reference to commerce, in the truest interest of art, and made the successful uphill fight against a singular combination of unfavorable circumstances, and nearly always without the discriminating support, or even sympathy, of any considerable portion of their countrymen, and no recognition whatever from their Government.

PAINTERS OF THE UNITED STATES.

William S. Allen sent a small canvas of a young girl in gray. The sky and nearly all of the surrounding objects are of the same

tone. This work of undoubted merit is entitled "*Le soir, sur le bord du lac.*" It is well composed and delicately painted.

J. Carroll Beckwith exhibits three portraits. The better is the strikingly-lifelike portrait of William Walton. The composition is original, the painting bold and artistic. The others are less successful.

Edward A. Bell contributed a delicate scheme of color, in which he embodies the portrait of a lady. This was his only exhibit, and it is undoubtedly an artistic work.

Henry S. Bisbing was represented by a canvas entitled "*La sieste sur la plage.*" The drawing of the cattle, the details of the landscape, and the treatment of color render this more interesting than most compositions of the same kind; but it is not to be compared to a painting of very exceptional merit exhibited by Mr. Bisbing in the Salon of the present year, 1889.

Robert F. Blum sent his "*Dentillières Vénitiennes,*" a room full of young Venetian women making lace. This is a well-known picture, and is undoubtedly of considerable artistic value. The composition is well conceived, the figures are daintily painted and gracefully posed, and the action generally is good; but there is at one end of the canvas an unfortunate streak of green, and at the other a corresponding one of yellow, and these rather startling blemishes mar the effect of the whole.

Frank M. Boggs contributes three pictures. The most important is the "*Place de la Bastille.*" It belongs to the French Government. In this we have an extreme of what might be termed in art the "French Gray." The sky, the column, the surrounding buildings, the carriages, horses, men, women, and pavements are all gray. But the work is striking, and gives a vivid picture of the scene.

Robert B. Brandegee contributes one among the few fine portraits in the American section. It is simple, quiet, and direct, is free from tinsel effects and undue ornamentation, and is the result of an earnest effort in the right direction.

Frederick A. Bridgman, a well-known painter of Eastern subjects, is represented by six works. The one that commands attention most is "*Le pirate d'Amour,*" a picture in three compartments. In the first we see a young Egyptian girl reading upon a terrace, and just above the parapet the face of a man gazing at her with an expression that corresponds to the title of the picture. In the second compartment the ruffian is struggling with the girl, and in the third she is lying dead in a pool of blood. The second canvas was a puzzle to the French critics; the struggle was not thought by them to explain itself with sufficient clearness. No one, however, need wish the unpleasant story to be told more plainly. It is a spirited and decidedly dramatic picture. "*Fête du Prophète à Oued-el-Kebir,*" and "*Fête Nègre à Blida*" are good examples of the work of this painter, but



THE QUARTETTE, BY DANNAT.

there are better artistic qualities in his "*Marché aux chevaux au Caire*," than in any of those previously mentioned. The horses are remarkably well drawn, and they show their Arabian breed unmistakably. The artist's portrait of "*Madam B.*" is striking, and proves that he has the power of vividly reproducing the expression of a human face.

Of the three works contributed by Howard Russell Butler, "*Récoltes d'algues marines*" pleases most by its truthfulness. The land and all the details of the coast are very artistically represented.

William M. Chase is a painter of many pictures, embracing a wide range of subjects. Of the eight now exhibited, five are very small landscape studies, and three are portraits. Among these last is one of "*Mrs. G.*," which is in every respect a most commendable work. The full length figure has an easy and natural pose. It is carefully drawn and painted; the general effect is dignified and free from any trick of the trade. One of the other two is unworthy of the artist who painted the one described.

William Anderson Coffin is a close observer, and his four landscapes in this Exhibition proves that he knows the value of the simple forms in which nature abounds. His "*Claire de lune*" is an original and ambitious attempt not altogether unsuccessful, to represent an effect of nature full of technical difficulties.

Kenyon Cox is an earnest seacher after truth, working in many directions, and his four exhibits fairly represent his capabilities. His portrait of Saint-Gaudens, the sculptor, in his studio, is faithful and forcible, and the best of his present exhibits. "*Ombres fuyantes*"—passing shadows—is a curious study of nature, but can not be regarded as a successful or pleasing work of art.

William P. W. Dana is represented by four works, of which the largest and most ambitious is "*Le Christ marchant sur les eaux.*" Of this it can only be written that if its execution had been as correct as its conception was grand, it would be a work of rare dignity and impressiveness. The other three fall much below the merit of a great marine by that artist, called "*Solitude*," and exhibited in the Exhibition of 1878.

William T. Dannat observes carefully and constructs intelligently. He has qualities which are recognized not only by Americans, but by people of other countries as well. Of his six pictures now exhibited, three represent his most characteristic work. First of all should be mentioned "*Un quatuor*," which will always rank among the masterpieces of American art. It is thoroughly and unmistakably Spanish. If Cervantes or Le Sage had been artists and had painted it, it could not have been more typically and truly Iberian. It is full of life and action, but the effect is obtained without any apparent effort. We feel that the man who is singing is doing so with all the power he possesses, but he is quite at his ease. The young Spanish woman, who is

playing the castanets, is throwing all the force and earnestness of her southern nature into the work, but in this expressive physical action there is repose. The same may be said of the mandolin and guitar players in the background. The picture is replete with expression. The drawing of the figures is correct, the costumes are accurately painted, the scheme of color, low in its tones to somberness, is nevertheless rich and harmonious. In a word, the painting is a consummate work of art. The portrait of "*Mlle. H.*" is another sincere painting by this artist. It is only the head of a blond young girl, but it is so simply and truly done that it seems to take us back to the best period of the Dutch school. "*Une sacristie en Aragon*" takes us again to Spain, for it is essentially Spanish. A fat, monumental, well-fed priest sitting erect in his sacristy, is in conversation with a Spaniard of the lower order, seated by his side and evidently admiring him. From the expression of the ecclesiastic we feel sure that a very important question has been submitted for his consideration. This work is somewhat satirical. The condition of the priest does not tell the story of long fasts and many fish days. The work is quiet in color, but strong in general treatment. The three remaining paintings by this artist are not in his usual vein, but they show great technical skill.

Charles H. Davis is one of the most distinguished among the present American landscape painters. He has the faculty of selecting simple and beautiful phases of nature, and he paints them in a broad, tender, and unaffected manner. Of his four works now exhibited, "*Une soirée d'hiver*" is the most noteworthy as regards composition and original treatment.

Thomas W. Dewing is one of the better of living American *genre* painters. Unfortunately he is represented by only one work, "*Femme en jaune.*" It is a full length figure of a young woman seated and dressed in yellow. It is an exceptionally artistic little work. The pose is a trifle stiff, and there is an entire absence of anything like sprightly coquetry, which is so telling in a pretty woman. We turn away from this with the satisfaction of having contemplated the "counterfeit presentment" of a perfectly and severely correct specimen of well-bred womanhood.

William L. Dodge has the distinction of having contributed the largest canvas to the American section. It is entitled "*David,*" and represents the biblical hero standing over the body of his late gigantic foe. The figure of David is dramatic, and is drawn with considerable power. In the distance there is a shadowy idea of an innumerable host. After contemplating this scene one feels that the story might have been told just as well upon about a quarter of the canvas.

G. Ruger Donoho is represented by two large landscapes. The

one named "*La Marcellerie*" is far the better of the two, and is a very close and carefully painted study from nature.

Henry F. Farny's "*Le danger*" depicts an Indian riding down the slope of a mountain grasping his rifle and evidently on the lookout for an expected foe. The subject is graphically and artistically treated.

Frank Fowler exhibits a portrait under the name of "*Au piano*." It represents a woman on a piano stool, turned away from the instrument. The pose of the figure is easy, and the work has a decided merit both as regards composition and color.

Gilbert Gaul is the only American artist who has devoted his talent to the painting of scenes from our late war. Of the two sent to this Exposition, "*Chargeant la batterie*" is the more interesting. We see a body of infantry charging in the direction of the lights caused by the firing of artillery. The movement of the charging column is free and natural and gives a good idea of the reality. The subject of the other canvas is a wounded officer being held upon his horse, and it gives a fairly true picture of such an incident.

Walter Gay has passed the whole of his artistic career in France, and has justly gained a considerable reputation as a careful painter of *genre* pictures. Within the last three or four years he has changed his style, and now devotes himself to the showy gray and coarsely effective. "*La Charité*," which is the largest of his six exhibits, is an ultra example of his present work. That it is effective there can be no doubt; but if it is artistic it can only be so at the expense of truth and by a violation of rules which govern the natural relations of the simplest realities. Several of his other works are quieter in color and general execution and approach more nearly the true in art, but their value is not equal to that of his earlier works.

Carl Gutherez is represented by two works. One "*Lux Incarnationis*," is highly imaginative, and must have cost the artist much thought and labor. It is a daring effort of fancy, and the painter deserves credit for thus straying from the path of the commonplace.

Alexander Harrison stands among the strong artists of his time. He has conquered the ocean and made of it an art field peculiarly his own. No artist represented at the Exhibition has painted the sea more truthfully than he. He prefers the simplest moods of the ocean, the most quiet and measured of wave forms, and transfers his impressions of them directly to canvas. In his pictures there is no attempt to paint the effect of blustering wind and the beating of waves against rocks; he prefers summer quietude and broad, sweeping, easy wave movements. His water tints are as close to nature as paint and brush can make them. "*Crépuscule*" and "*La Vague*," two of his six works in the Exhibition, are excellent examples of his seascapes. "*En Arcadie*" is a grassy, almost sylvan scene, with nude figures and much sunshine. "*Chateaux en Espagne*" is a pic-

ture of a boy stretched at full length at the foot of a sandhill by the sea. Tired of playing with shells, he is now gazing dreamily into space. This is undoubtedly one of the artist's better works; the open-air effect is admirable, and the old story of boyhood's dreams is told with such simple strength that any one can understand it.

Birge Harrison's "*Novembre*" is the only picture by this artist in the Exhibition. It is the one that produced such a favorable impression in the Salon several years ago, and was purchased by the French Government. It is a truthful and charming picture of a reposeful chestnut wood in late autumn, with the simple figure of a peasant girl to relieve the solitude. The ground is strewn with red leaves. The painting is quite free from exaggeration.

Edward L. Henry contributes two works. In his "*Il y a cent ans*," we have a faithful representation of a southern scene a hundred years ago. The yellow cabriolet, the negro coachman in livery, the continental costume, and other details, graphically revive the place and period. This artist deserves credit for trying to keep alive in the minds of our countrymen some idea of the only picturesque period in our national history.

George Hitchcock works within limited lines, but there is an individuality in what he does. "*La culture des Tulipes*," when exhibited at the Salon, caused a little "sensation" among the critics. It depicts a Dutch girl walking in a garden of quadrangular tulip beds of different colors. The subject is a commonplace one, but it has been so artistically handled that an interesting picture has been made of it. His other two works now exhibited, "*L'Annonciation*" and "*Maternité*," are cousins-german to the first named. In each there is a woman walking among flowers. They are eminently artistic, and are marked by a rare tone of refinement.

William H. Howe exhibits three landscapes with cattle. Two are large and very interesting compositions. "*La rentrée des vaches*" is very broadly treated, and the whole construction of the work shows careful study and artistic appreciation of the value of picturesque forms. The cattle are well drawn, and their action natural. "*Le Repos*" is another and a large work, showing the same qualities as the one described.

Daniel Ridgway Knight is among the most successful of American artists of to-day. His work is popular for its pleasing qualities, and as a rule is picturesque. Some artists assert that he elaborates and finishes too much, that his peasants are too well dressed and clean of face, that they savor of the Opera Comique, etc. Their cleanness, however, if imaginative, is a relieving merit, since they are usually painted so dirty. If, as is alleged, Mr. Knight does take liberties with the exact truth, he should be forgiven, for his error is in the interest of the beautiful—as he sees it.

One of his three works now exhibited, "*L'Appel au passeur*," is

eminently representative of his style. Two of his peasant girls are on the bank of the Seine hailing a ferryboat on the opposite side. They are clean, smiling, and pretty, and such girls as any person of taste would be willing to know. The landscape is soft and harmonious in tone. The whole is well composed and worked out with a just observation of natural forms. His other two works set forth his merits or demerits as an artist, but not so strongly as "*L'Appel au passeur*."

Walter MacEwen has contributed three Dutch scenes of considerable interest. They are all figure pieces and interiors. "*Une histoire de revenant*" shows a much scattered group of women spinning, dressed in red, and covers almost in a line, the whole length of the canvas. This work has many strong points, and if it were not for its faulty composition it would be of great artistic value. The other paintings are likewise of conspicuous merit.

J. Gari Melchers is another of the young American painters possessing originality. In his researches among the Dutch he has found something new, although it is as old as the people themselves. He has observed something in their daily life worth painting that no artist had seen before in the same way. Such discoveries are only made by the close observer and careful student of human nature. "*La Communion*," the largest of his four canvases, gives the interior of a Protestant church; plain walls, desk, seats, and table, the clergyman in his professional garb in the act of administering the sacrament to the working-class congregation in their carefully preserved clothing of many colors. A feeling of sincere and confiding devotion pervades the whole scene, which is singularly impressive. Were it not for the strange hardness of the flesh tints, which give the faces an almost wooden appearance, this work might be regarded as a complete artistic success. In "*La Prêche*," another church interior of smaller size, the hard painting of the larger work is to an extent avoided. "*Les pilotes*" an interior with a group of Dutch sailors smoking, has still less of this color hardness. It is typical and full of character, a homely scene truthfully and artistically painted.

H. Humphrey Moore exhibits a considerable number of small studies from the everyday life of the Japanese. Several of these are singularly artistic in treatment, and they have the advantage of being actual scenes drawn on the spot by a careful observer.

Henry Mosler has made himself master of the Brittany peasants' households. He portrays with equal force their joys and sorrows, and many of his works suggest that he must derive a solemn pleasure from depicting the pathetic side of their lives. "*Le retour*," "*Les derniers sacrements*," and "*Les derniers moments*," the first named in the Luxembourg Gallery, and the two last in the present Exhibition, are all pitched in the same key, and in each the interest centers

upon a death scene. These works tell their story in such a manner as to excite the sympathy of the beholder.

J. Douglas Patrick is represented by one large canvas, "*Brutalité.*" It is the oft-told tale of the heavy load, the weary, willing horse, the brutal driver armed with a club beating the overworked animal which accident has placed in his power. The picture is a telling one; in looking at it one realizes all the baseness of the too common acts of cruelty towards one of the noblest and most useful of the animal creation.

Charles Sprague Pearce commenced his artistic career by successfully painting scriptural subjects. He afterwards produced some very clever *genre* pictures, and latterly we find him perfectly at home among the peasants and sheep pastures of Picardy. In this Exhibition he is represented by four works, of which "*La bergère*" is the most important. The picture is large and decidedly of the "French grey" order now in vogue, but this particular grey is the property of the artist. The subject is a young peasant girl tending a flock of sheep on the side of a hill. Her attitude and her pensive expression indicate that her thoughts are wandering far away from her flock. Perhaps she is longing for the indefinite brighter days. There is fine sentiment in this genuine bit of rusticity, and in the treatment of outdoor effects the artist has shown great technical skill. This painting has received more official honors than has usually been bestowed upon the better works of American artists. The list is as follows: A third-class medal at the Salon of 1883; a gold medal at Munich 1887, and a special gold medal of honor, the highest awarded at Ghent, in 1888. The three other works exhibited by this painter likewise convey a good idea of his artistic qualities.

Henry G. Plumb contributes the smallest canvas to the American section. It is called "*Les Orphelines,*" and represents the mother mouse caught in the old-fashioned trap, head in wire and body out, while the interesting family of little orphans are trying to solve the mystery of her stillness. The story is so pathetically told that we turn away from the picture hating the inventor of the cruel trap.

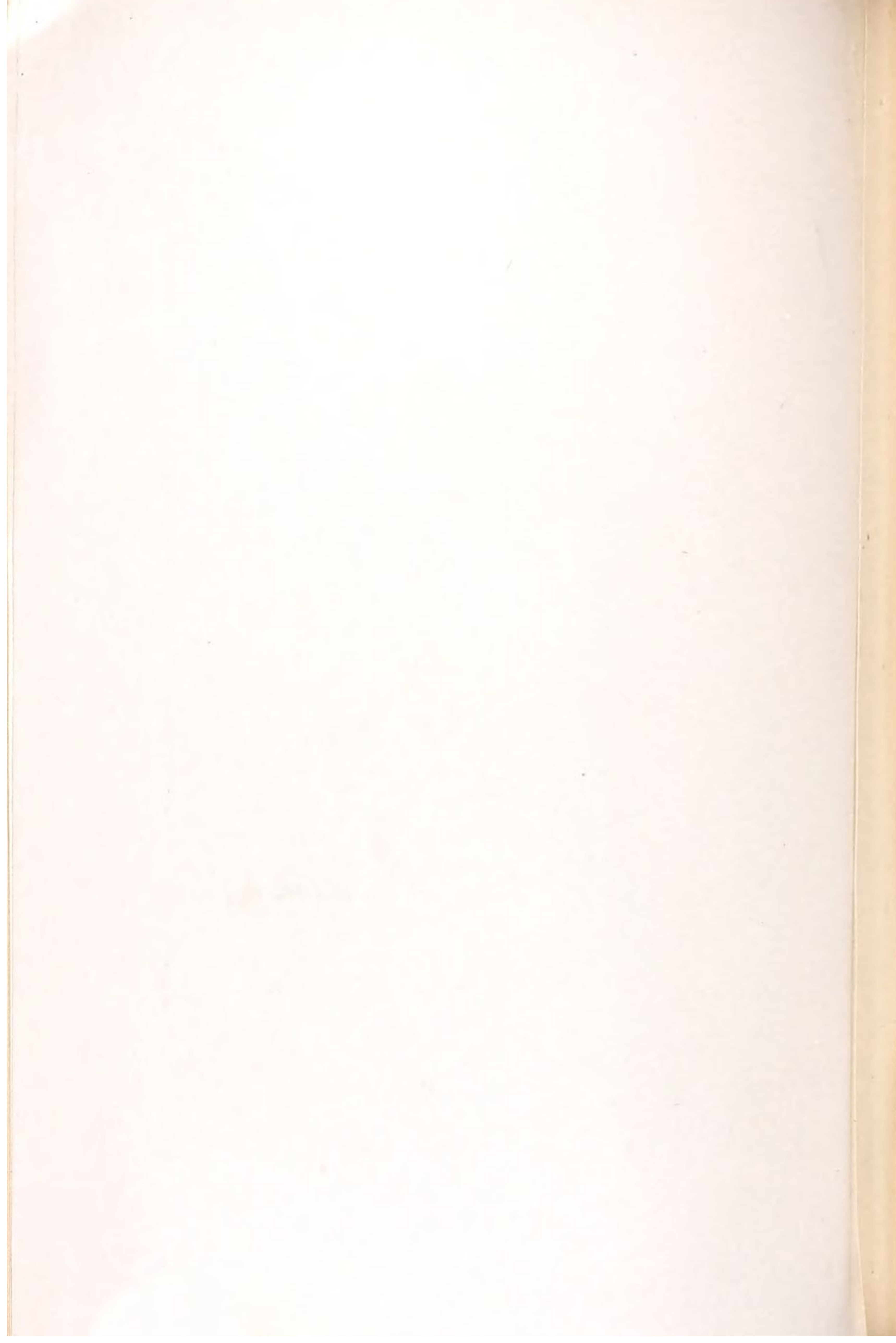
Charles Stanley Reinhart is represented among the oil paintings by six canvases. The largest and most ambitious are "*Une épave,*" and "*L'attente des absents.*" The first is a coast scene of a group of fisher people and a *gendarme* assembled near the body of a drowned sailor; the second is a group of women on the anxious lookout over the sea for absent relatives. Both pictures are spirited and lifelike reproductions of actualities, and prove conclusively that this artist has the faculty of graphically depicting what he sees. His other oil paintings do justice to his capabilities.

William T. Richards, the best known of American marine painters, is represented by one notable canvas. It is a coast scene, artistically treated, but it is not an example of his better work.



THE SHEPHERD





John L. Sargent, in the opinion of those who think they know and have the right to judge, stands at the head of American portrait painters of the day. London, Paris, and New York have accepted the fiat of these self-constituted judges. The artist is now represented by six pictures, two of which are undoubtedly of surpassing merit as works of art. The large canvas of the "*Boit children*" leaves neither desire nor opportunity for criticism. It is so warm and rich in tone that it might have been painted by one of the Venetian masters of color. The children are charming in expression and pose. The painting is beyond all peradventure one of the most successful of those which in our days have attempted to depict childhood in the midst of luxurious surroundings. Indeed, the writer does not know where among the works of modern painters its superior in several respects is to be found. Next in merit is the portrait of "*Mme. W.*," a full length in white. It is simply composed, perfectly free from any attempt at boldness in effect, and gives us the idea of a woman of perfect breeding and refinement. Of the remaining four, that of "*Madam B.*" is the better, although it bears the unmistakable stamp of a society portrait, and of a woman who has perfect confidence in her "social position."

Julius L. Stewart is another of the successful Americans. He is the painter of thoroughly *chic* portraits of women, and works by a well conceived formula which always produces genteel results. He never paints a woman who appears to be of lower rank than that of baroness, and all his young girls look like the daughters of duchesses. It is unnecessary to say that his portraits are always acceptable to the sitters, as indeed they ought to be, for they are takingly composed, and as to general effect, perfectly genteel. His six works now exhibited show us an artist of more than ordinary ability, and thoroughly accomplished in a certain kind of technique. The prevailing defect in Mr. Stewart's portraits is the sameness of values. From top to bottom, and from side to side of the canvas, the same degree of distinctness is always visible. His "*Hunt ball*," which is regarded as his most notable work, is showy and original. It is a pretty picture of the world's airy nothings, engaged in an occupation which is taxing their intellects to the extreme of mental tension. The men in red coats beating tambourines, and the women so unexceptionally garbed, must remind all Americans of the dangerous and exciting anise-seed bag chase, and the "Hunt ball" of their only Newport. The artist, probably without intention, has produced a most telling satire. If he had spent a life time in experimenting, he could not have created a collection of more thoroughly vapid faces—fronts upon which vacancy enthroned sits supreme. The "*Hunt supper*" is a companion picture. "*Une Cour au Caire*" is a work of merit, and shows this artist at his best; but it is not one of his fashionable productions. "*La berge à Bougival*" is a river

side scene in the outskirts of Paris, well composed, and fairly artistic in treatment.

Julian Russel Story exhibits three works, including a portrait of his father, which is one of the best in the American section. It is new to this period, but very old in its manner of color and free handling. The very large canvas by this artist represents "*Le Prince Noir trouvant le corps du roi de Bohême après la bataille de Crécy.*" It is a most ambitious painting, but notwithstanding the fact that it is fairly well composed, it can not be regarded as a remarkable work of art.

Abbott Henderson Thayer has only one canvas, and this makes us regret that there are not more. It is "*Corps aile,*" an original and imaginative work, and one of the most charmingly painted heads in the whole Exhibition. It is a conception of rare refinement.

Wordsworth Thompson sends a canvas entitled "*Une ferme de New England.*" It is a work of merit, and those who know the ground, with its peculiar associations and features, will recognize the truth of the picture.

G. S. Truesdell is likewise represented by a single painting, "*Le berger et son troupeau.*" It is a quiet truthful picture of a shepherd and his sheep, of more than ordinary power.

Charles F. Ulrich has contributed his "*Dans la terre promise.*" This, his best known and most ambitious work, depicts an everyday Castle Garden scene, filled with newly arrived emigrants. They are typical Germans seeking their earthly salvation in the new land of promise. The various types are well depicted, and the whole composition is wonderfully true.

Eugene L. Vail is a very strong painter of marine subjects, and his manner is peculiarly his own. He has his own way of looking at objects, and his own scheme of color. Of his four works in this Exhibition, the "*Porte de pêche, Concarneau,*" is very noteworthy. The subject is a fishing-smack with the wind on the port beam. Two men are at the ropes, and a third is steering. The boat is passing along the side of a wonderfully constructed wave-form in ponderous motion. The composition, the action, and the quality of color in this painting prove an artist of exceptional power. His other three works are strongly artistic, and are as distinctively his own as the one described.

Horatio Walker shows a strong bit of color in his "*Étable à cochons.*" It is not an interesting subject, except perhaps to the mind of a pork-packer. To an ordinary person a pig sty is not a thing of beauty, but as a study of color and composition this work would do credit to George Morland.

E. L. Weeks is an artist who composes and paints from sketches made in the East. Since he has forsaken Egypt, India has seemingly been to him an inexhaustible field. The scenes of this country he

contrives to bring in a most picturesque manner before the peoples of the West. He paints with rare fidelity and artistic effect, and it is doubtful if the works of any artist convey better pictures of Eastern life. One of his chief paintings, which is also among his latest, is "*Le dernier voyage; souvenir du Gange.*" It shows the artist at his best. The view of the city of Benares is remarkable for masterly treatment of architectural effects. Two fakirs are crossing the Ganges in an open boat; one is dying, and the other is using all haste so that his comrade may breathe his last on the sacred shore. The strange buildings, the water with its reflections, the Eastern costumes, and the brilliant Indian atmosphere, render this artistic composition extremely interesting.

J. Alden Weir exhibited three oil paintings. One, "*Portrait de l'enfant d'un artist,*" is a quaint picture in an old style, approaching the Dutch school, and none the worse for the resemblance. The other two—an example of still life, and a landscape, are likewise artistic, but of no particular force or art value.

PORTRAIT PAINTERS.

Among painters of portraits, whose work is fairly representative of the present condition of American art, may be mentioned the following exhibitors: Anderson, Mlle. Beaux, G. B. Butler, Cauldwell, Delachaux, Eakins, W. Eaton, Forbes, Healy, Hinckley, Huntington, Isham, Johnson, Mlle. Kellogg, Mme. Klumpke, Lockwood, Meza, Newman, Peters, Porter, Renouf, Rice, Strickland, Tarbell, Throop, Vonnoh, Wight, and Wiles.

LANDSCAPE PAINTERS.

Among the representative landscape painters who have sent works are, Benson, Boyden, Birch, Bristol, C. H. Eaton, Fisher, Gifford, Gross, Haas (Marine) H. Hamilton, J. M. Hart, Hassam, Hayden, Innes, Bolton Jones, MacEntee, Macy, Miller, Minor, Nicoll, Parton, Robbins, Van Boskerck, Whiteman, Whittridge, Wickenden, Ogden Wood, and Wyant. Several of these painters have devoted the better portion of their artistic careers to the delineation of American scenery, and have done so with success.

HISTORICAL AND GENRE PAINTERS.

The list of historical and *genre* painters does not contain many names that can be bracketed with notable works. The following, however, may be mentioned as having been fairly successful: Bacon, Baird, Birney, Blashfield, J. G. Brown, Darling, Denman, Dolph, Freer, Elizabeth Gardner, Hovenden, Irwin, Kavanah, Koehler, Millett, Moeller, Potthast, Ryder, Shirlaw, Stokes, Turner, Vedder, Volk, Ward, Webb, Witt, and T. W. Wood.

WATER COLORS AND DRAWINGS.

In the second class, which contains various original designs in water color, pen and ink, etc., the American exhibit is small but strong. At the head of the list, and among the first of his time stands Edward A. Abbey. He is a consummate master of graceful pose, costumes, and true elegance in composition. He moreover possesses the rare faculty of fixing upon a small surface the spirit and social tone of the period. Sheridan's immortal comedy, "School for Scandal," is not more remarkable in this respect than one of Abbey's drawings. He is a perfect master of the *technique* which serves him to elucidate his dainty creations. The work of this artist will stand the test of time as well as that of any of our great representative poets.

Charles S. Reinhart is also a notable draftsman, but in quite another direction from Abbey's. He is among those keen observers who content themselves with noting persons and things of to-day. He appears to perceive without difficulty an unknown side to the most commonplace object, and he has a happy and graphic way of presenting these commonplaces so as to make them amusing and interesting. He has fertility of imagination and the command of a facile pen.

The two pastel portraits by Julius L. Stewart are particularly interesting for graceful pose and simplicity of execution. Robert F. Blum, William H. Low, Fred Remington, Julius Rolshoven, Rosina E. Sherwood, William J. Whittemore, Kenyon Cox, J. Alden Weir, William H. Drake, Eliza Greatorox, Joseph Pennell, Irving W. Wiles, E. H. Blashfield, M. H. Gibson, A. C. Redwood, and several others are represented by very meritorious works.

SCULPTURE.

In the class of sculpture the American exhibit is insignificant as to numbers and weak artistically. S. H. Adams, has, however, a bust of a young girl which is thoroughly good work. It is free and sincere in treatment, and devoid of all littleness tending to detract from the dignity and effect of the whole.

Paul Wayland Bartlett contributes a purely ideal work "*Le Bohémien*,"—a full-length statue in bronze. A young man (nude) is teaching two little bears showman's tricks. In this group there is undoubted evidence of original design. The artist has something to say, and he has said it with masterly simplicity. The cubs show admirable study of character in animals. The silent protest of the one that is being taught, and the satisfaction of the other at having gotten through with its lesson, are expressed with consummate skill. The modelling of the man's figure, the attitude and expression of the face are excellent. For this work the artist was voted a



THE BOHEMIAN, BY BARTLETT.

“*grand prix*,” which on account of his being a *supplémentaire* on the jury, he was not permitted to accept.

H. H. Kitson is represented by the bust of a young girl possessing much merit, and a colossal plaster statue of Mayor Doyle, late of Providence, Rhode Island. A bronze of the same composition has been erected in an open space in that city. This work is much better than most statues in contemporary costume. The artist made a mistake in giving it 11 instead of 7 feet. Mayor Doyle was very well known in Rhode Island, but not far beyond. He made an honest mayor, but was hardly a hero for a poem, or intellectually 11 feet high. What a benefit to society it would be, if in the republic of art a law were enacted prohibiting the production of statues in the unbecoming costume of this period. It might diminish the profits to foundries and stone-cutting yards, but what a blessing to art.

Miss T. A. Ruggles is a very young sculptress who has given evidence of considerable talent. Her bronze bust of a child is an oddly artistic composition, which might have been done in Italy three hundred years ago. It has a perfectly clear, early Italian flavor, but is still her own. The other “*Bords de l’Oise*” is a statue of a nude child in an exceptional position, and modeled in a way that would do credit to many older hands.

Olin L. Warner has two good portrait busts, three medallions in bronze, and a little head in marble—“*La petite Rosalie Warner*.” This last is of striking merit. It is the smiling face of a little child. The lines are so true, and the modeling so deft, that we can almost feel the pulpy softness of an infant face.

ENGRAVINGS.

In the class “Engravings,” Aikman (Miss), Bernstrom, Closson Cole, Davidson, Davis, French, Johnson, King, Kingsley, Kruell, Lindsay, Miller, Caroline A. Powell, Putnam, Smithweck, Standenbaur, Tinkey, Varley, Wellington, and Wolf, are represented by one hundred and two wood engravings. The writer assumed the responsibility of having them classed in the general official catalogue under the title of “*Ecole Américaine de gravures sur bois (Exposition Collective)*.” Immediately after the opening of the Exhibition he had the satisfaction of knowing that his decision had been approved. It is very gratifying to know that in this particular field of art our workers held their own against the best of other countries; and, moreover, to feel that the high standing of our wood engravers is so generally acknowledged. It would be exceedingly difficult to speak of this or that artist represented in the collection without mentioning all, for the general evenness of the work is as remarkable as its excellence. It is in the knowledge of the writer that the jury did not make its awards until after many hours of careful con-

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sideration, and even then it was not quite settled in the minds of all that exact justice had been done. This fact must be regarded as most complimentary to the artistic merit of the whole collection.

FINLAND.

The contributions from Finland to the Exhibition, number seventy-seven, of which fifty-seven are oil paintings. The exhibit as a whole is not attractive or notable for artistic qualities. As a rule, the endeavor to depict the beautiful is more observable in the works of the Finnish artists than those of Danish painters; but their art, although it may not be absolutely repulsive, is coarse and unsympathetic.

FINNISH PAINTERS.

A. Edelfelt, who works in Paris, is an exception among his countrymen. He is a painter of rare power of expression and fidelity to the best laws of art. His finer works go far in the direction of true greatness. The one to be especially noticed of the ten he exhibits is the full-length portrait of Pasteur in his laboratory, in the act of examining the contents of a bottle which he holds in his hand. The attitude and expression of mental absorption are perfectly portrayed, and the great student stands before us in all the earnestness, dignity, and simplicity of his character. "*La Vierge et l'enfant*," is a work of novel interest, for it gives a new interpretation of a much hackneyed subject. The scheme of color might with perfect propriety be designated as spiritual, it is so light, transparent, and ethereal. While it is the reverse of all that is solid in color, it is yet strongly expressive. "*Au piano*" is another small work also delicate in color, and the "*Portrait of Mme. S.*" proves that this artist has much versatility in portraiture. The face in this picture is singularly expressive of a kindly nature and simplicity of character.

With the exception of "*Débarquement*," by A. Jarnefelt, there is no other picture in the Finnish section that seems to the writer worthy of particular mention.

GREAT BRITAIN.

The contributions from Great Britain number five hundred and fifty-two, and in each class there are to be found a sufficient number of works by representative artists to give a fair idea of the present state of the fine arts in the United Kingdom. In artistic qualities, especially in all that relates to color, this section stands quite by itself. In general composition and intention the exhibit is unlike that of any other country. Among the oil paintings are to be perceived many attempts to imitate the depth, solidity, and warmth of color so characteristic of the old Italian and Flemish masters. The French gray, so much in vogue on the continent, has evidently not

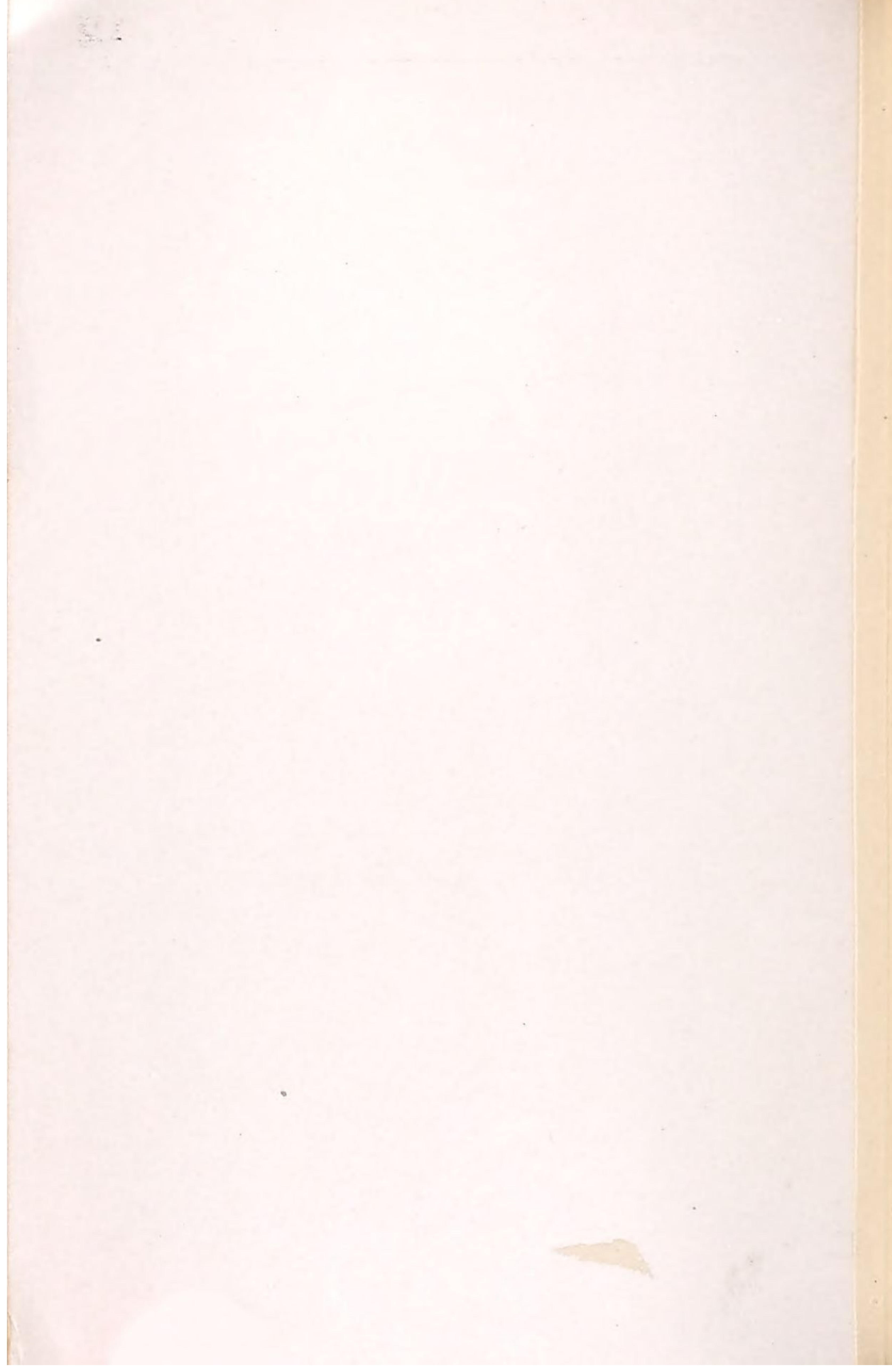


UNITED STATES PAVILION

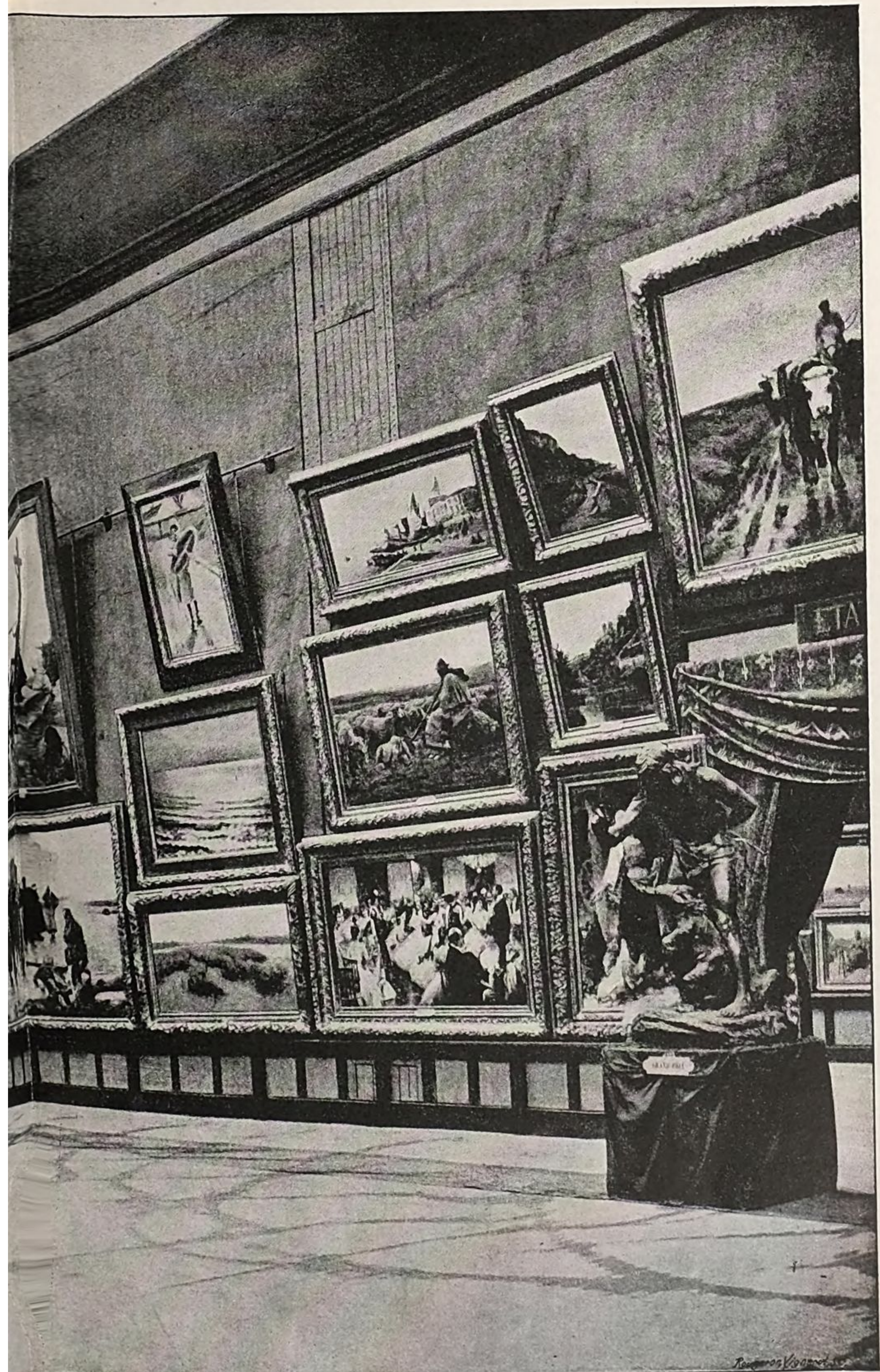


Reuben Vignard, S.C.

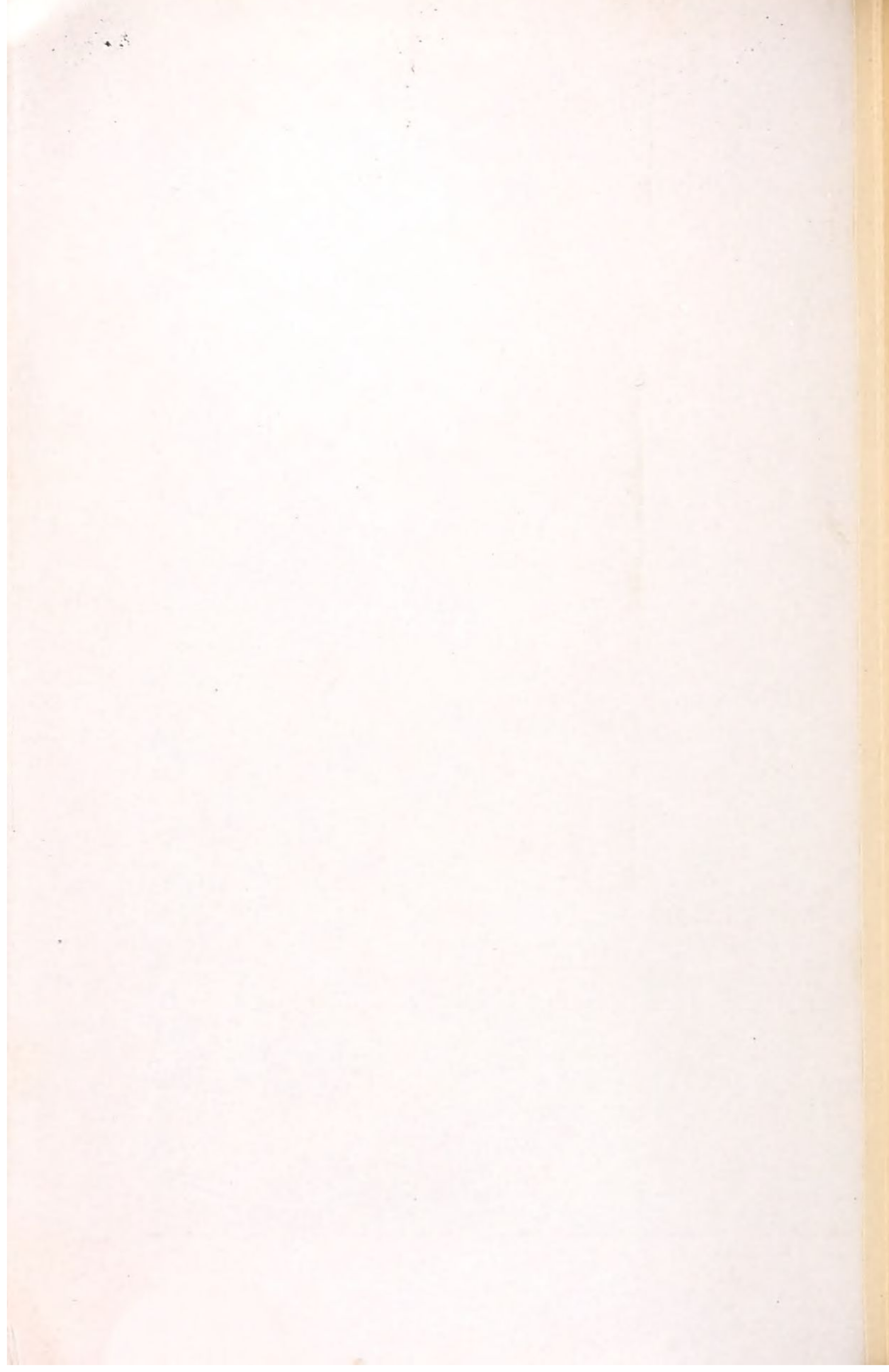
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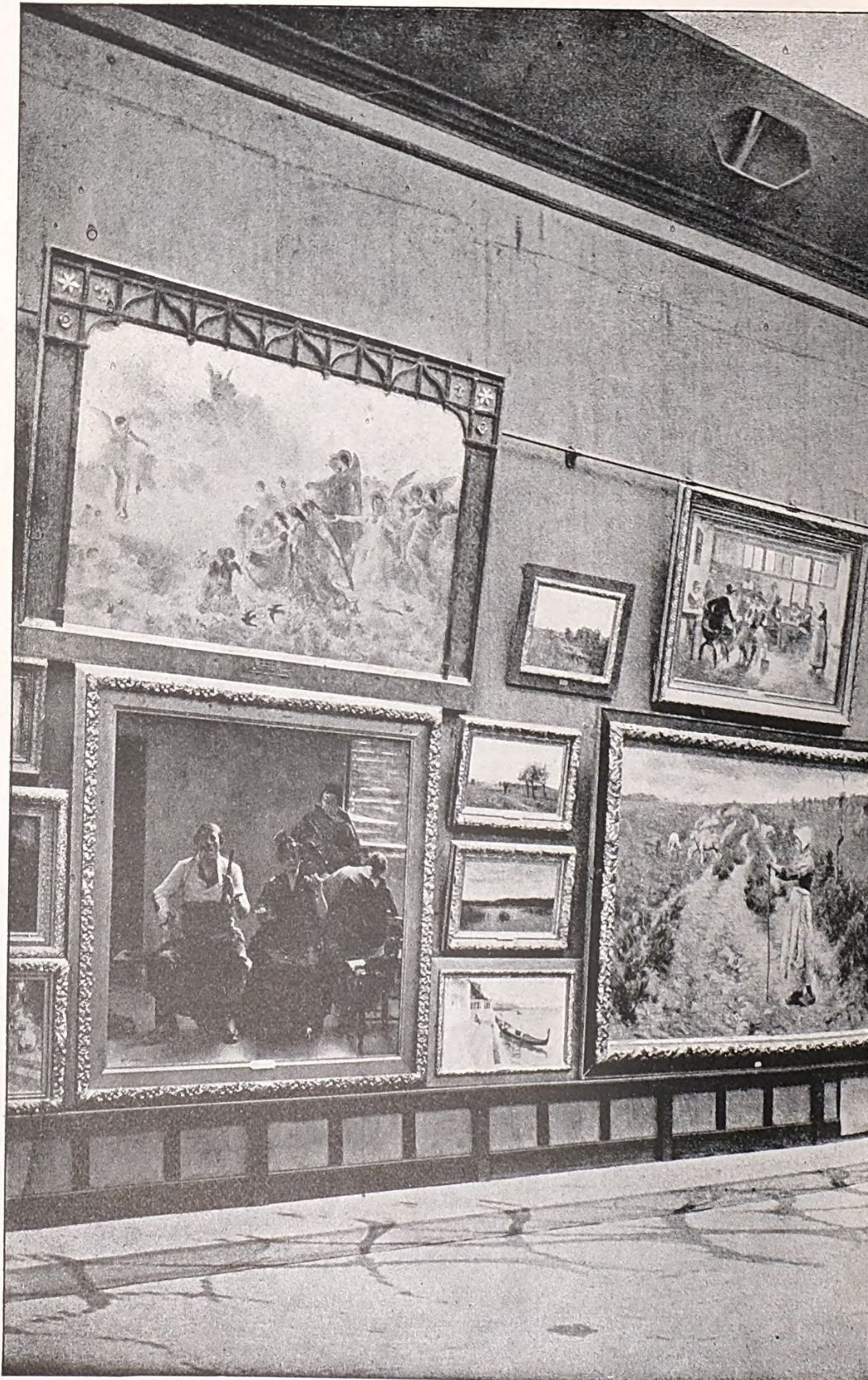






FINE ARTS SECTION.







FINE ARTS SECTION.





reached the English side of the channel, but there is a clearly-defined British tendency in the direction of painting "pictures," such as delighted the readers of the "Annuals" forty years ago, and with which the catchpenny novels were garnished for many successive seasons. In this class of work the general texture is always velvety and highly colored—very blue eyes, very round, red cheeks, very red hair, very black hair, deep green grass, etc. Nature is ignored, but the picture is produced all the same. Notwithstanding this tendency there is a goodly proportion of historical and imaginative work, betokening studious research and an earnest striving for something above the uncouth realism so often depicted by continental artists. There is also some excellent work in black and white. Everything is pervaded by a spirit of perfect respectability. There are, to be sure, a few nudes of the strictly clothespin order, painted, as a rule, in such a repulsive and untruthful manner, and so far removed from any known nature, that they might be taken for nondescript divinities of an inconceivable world. No one would care to look at them a second time. But the presence of these creations does not affect the strictly moral aspect of the *tout ensemble*, and it is safe to say that in the whole English collection there is not a suggestion of unusual levity or a single touch of the brush that would "bring the blush of shame to the cheek of modesty." The triumph of the uses of art over immorality, either in suggestion or fact, is thorough and complete, and this, too, at a time when the temptation to be frivolous is so strong.

ENGLISH PAINTERS.

L. Alma-Tadema is among the better known of the artists now painting in England. He has worked in a particular field, and the reputation he has made has been won within narrow limits. He is now represented by two oil paintings and two water colors. Of the oils, "*Les femmes d'Amphissa*," important as to subject and size, is in his peculiar style. It is largely composed of female figures in Greek dress, and was suggested by a passage in "Daniel Deronda." It seems a painting without a purpose; no definite idea is expressed, and there is no central point of interest. The women are scattered all over the canvas. Those who face the spectator are English girls in ancient costume, and those shown in profile have much the same massive lines which form the head on the present American dollar. The picture is not remarkable for truthfulness of color, and several of the figures are too long. It has neither national color nor local flavor, and were it not for the costumes, this representation would stand for Gaul quite as well as for Greece. If it had been painted by an unknown artist, it would be pronounced a thoughtless "studio" picture; but having the name of a *great* artist attached to it, we are perforce compelled to call it a great work. The other oil by this artist,

"*L'Attente*" is a single figure, and is likewise marked by his peculiarities.

E. Burne Jones is another English artist who does not work in beaten paths, and there is much diversity of opinion respecting the merit of his pictures. That he is, as to this period, original, there can be no doubt whatever; but the value of his originality from an art standpoint is an open question. His single contribution to this collection "*Le Roi Cophetua*," is to the ordinary human intelligence a mystery. Possibly there may be a supremely enlightened one capable of interpreting its hidden meaning, for doubtless he has one which does not appear on the surface. It purports to tell the story of a king, who, disregarding the rights and traditions of royalty, is in the act of offering his crown to a beautiful beggar girl. But the picture seems to be in three parts on a single canvas. There are two dark brown heads at the top, representing chorister boys, a full length figure in the middle with death white arms and face devoid of expression, and another dark brown, almost black face at the bottom, all false in color and untruthfully drawn. The *ensemble* forces the conviction that the artist tried to paint a pre-Raphael picture. Altogether it is elaborate, devoid of dignity, and has the appearance of a recently discovered design for an ancient glass window; but its worst feature is its pretentiousness. It has the incorrect drawing of the pre-Raphael period without the color, and is so ornate with trivial details that it has none of the dignity of the works of those days, and like a proposition in several sorts of later poetry, needs an explanation. An eminent French critic has intimated that this artist is a follower of Mantegna.

J. P. Calderon has sent a little canvas entitled "*Aphrodite*." A fairly drawn and very solid nude figure is floating upon very blue water, with a rather lazy, graceful movement.

E. Crofts contributes "*Marlborough après la bataille de Ramillies*." It is an earnest attempt to give a view of a camp scene after a fight, but it is not a success if judged from the De Neuville standard. It lacks the dirt, character, and movement of an army of fighting men.

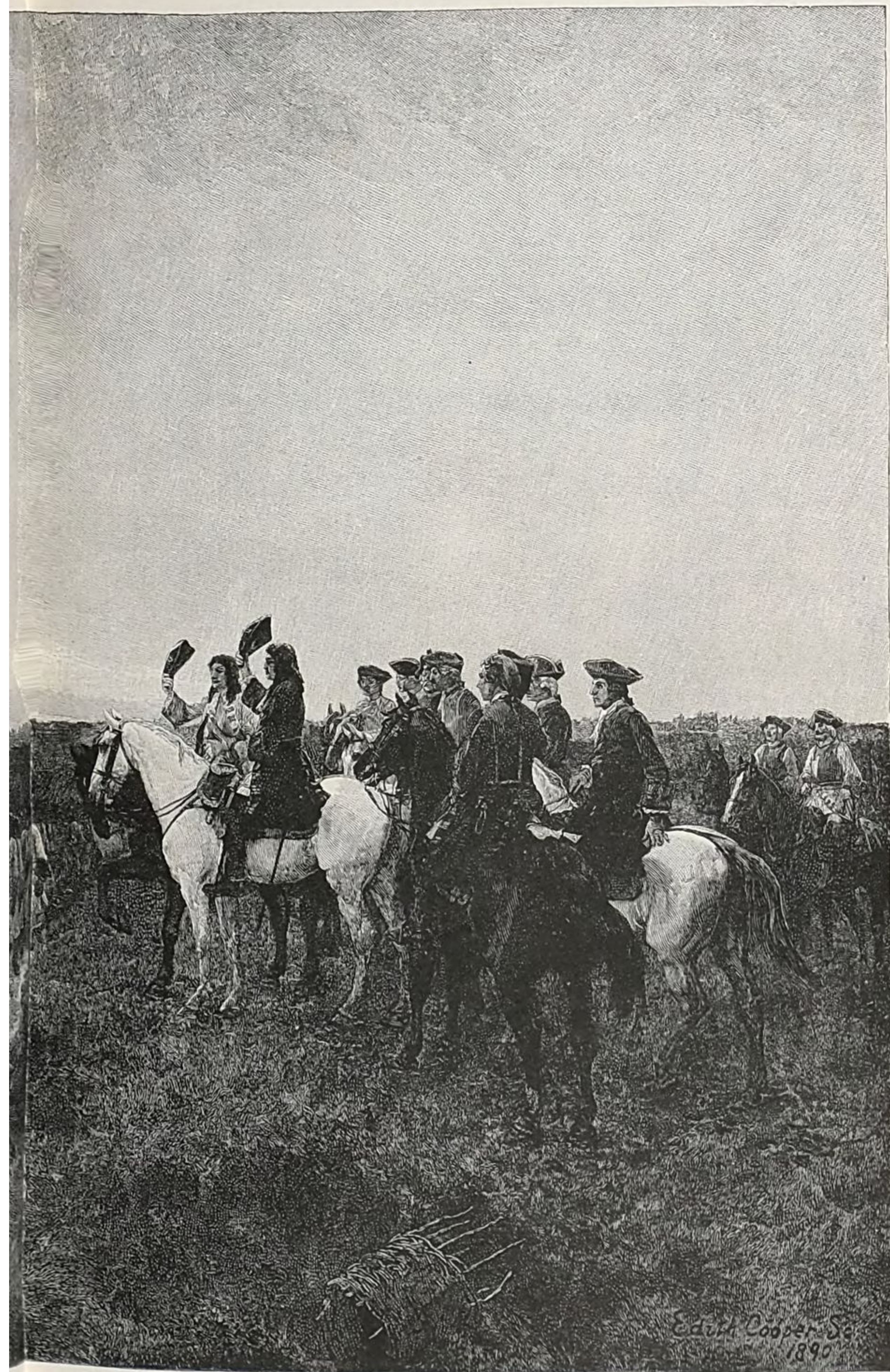
Luke Fildes is represented by three works, all of the picture-book, colored-plate order, in which are to be found several sets of very white even teeth, round red, brown, and white faces, round black eyes, and florid costumes. "*Venetiennes*" is eminently one of this kind. The others show the same qualities in a lesser degree.

Stanhope A. Forbes, in his "*Société philharmonique de village*" presents a scene in the everyday life of an English village, a vocal and instrumental rehearsal. It is a character work, and the English types are well marked. The action is good, and the whole is fairly composed. The artist's other work, "*Une famille de nomades*," is less successful.

Andrew C. Gow is represented by a very carefully painted and



MARCHING OUT WITH THE HONORS



well composed war picture, "*La garnison défilant avec les honneurs de la guerre, Lille, 1798.*" This is a thoroughly honest work and shows considerable skill for composition and picturesque outline. The group of mounted officers is well constructed, the men and horses carefully—a little too carefully—painted, and the battalion passing in front of them is fairly on the move. This artist, however, has made the common mistake of nearly all painters of war scenes, the men are too well dressed and too clean. The dirt and atmosphere of war are not portrayed.

H. Herkomer contributes two portraits of handsome women, one in white, the other in black. There can be no doubt about these being striking likenesses of the persons they represent. They are in several respects among the most thoroughly pleasing portraits in the Exhibition. In their broad and simple treatment they come very near to what is good in art. But the great volume and marble-like massiveness of the drapery of the one in white, and the grandiose pose of the other are the regrettable defects in these works.

The late Frank Holl is represented by a portrait of Sir H. Rawlinson. It is strong in color and drawing, lifelike in expression, and almost free from disturbing efforts at effect. One such blemish, however, in this otherwise excellent work, is a patch of red drapery on the left arm of the chair.

J. C. Hook, a marine painter and a colorist far above the average, has three works. "*Le départ pour le phare,*" and "*A quelque chose malheur est bon,*" are both paintings of decided merit. In each the effect of atmosphere is clearly indicated, and the wave movements are strongly depicted. The third painting is not so successful. The introduction or poorly executed human figures into the works of this artist mar the generally fine effect of their simple outline.

W. B. Leader is a landscape painter of ability. He is represented by a work entitled "*Sur le soir il y aura de la lumière.*" It is a broadly handled and luminous study from nature, and is executed in a manner that shows correct knowledge of atmospheric and outdoor effect generally.

Sir Frederick Leighton, president of the Royal Academy, and one of the most known among living English artists, has sent three paintings to the Exhibition. The largest of these, and the one that appears to represent his most serious attempt is "*Andromaque Captive.*" Imagine a large canvas covered with semiarchaic figures in several colors, "attitudinizing." The females are all of one family, with faces, hair, and expression as alike as possible, and clothed in porcelain robes of pronounced green, blue, red, yellow, and white, ample and voluminous; the nudes painted copperish brown, and all of these figures scattered over a canvas, or grouped in a way that betrays no intelligent purpose, and some idea of this extraordinary

picture may be formed. Several of the women are possessed of water jugs, and seemingly engaged in the occupation of carrying water, but their costumes, poses, and demeanor indicate that they are of the higher cast of Epirus society. Possibly it may have been painted with the intention of remotely imitating Pompeiian decoration, but what we know of that ancient art is in favor of its directness and simplicity, whereas Sir Frederick Leighton's work is enormously pretentious. It is an arbitrary production without local color, and represents Rome quite as much as Epirus. In the opinion of the writer it is an extreme presentation by a formalist, and is related in a very limited sense to natural objects. "*Simæta, la sorcière*" is a work of the same order, but the portrait of Lady Coleridge comes a little nearer the earth, and is altogether more satisfactory.

Sir John Millais is perhaps the most "successful" of living English painters. His works are very much sought after in England, and command high prices. Of his six pictures now exhibited, his portrait of Gladstone is the most complete and satisfactory. It is a profile, three-quarters length, on a dark background, and is painted in strict accordance with the best rules of portraiture. The face is expressive, the head well modeled, and the pose perfectly natural. Another portrait by this artist, that of Mr. J. C. Hook, is very different, in treatment, especially as to color, and might have been painted by anybody. "*Les Cerises*" is a pleasing picture of a child in "old English" dress. There is a decidedly old English air about the whole composition. "*Cendrillon*" is a figure simpler in execution, and less indebted to costume and surroundings for its value as a work of art.

Henry Moore is undoubtedly one of the very small number of good marine painters of his time. His two works "*Après la pluie le beau temps*," and "*La malle de New-Haven*," are excellent examples of his style. The first is the most attractive on account of the crisp effect of atmosphere, and the pure blue of the water. The sky is of a brilliant, transparent gray, and were it not for a rather heavy streak of dark cloud hanging over the fore center of the painting, and which seems to have no business there, the picture would be as nearly as possible a perfect work of art. As it is, it is a most remarkable production. The other canvas does not impress one so favorably, but it is nevertheless characteristic of the fine work of this artist.

W. Q. Orchardson is a distinguished painter with strong and well founded pretensions to be considered a colorist; his tones are unusually deep and warm, and in his finer works he is very exact in his relations and tone gradations. Of his three paintings now exhibited, "*Tout seul*" is a striking example of the marked characteristics of his better work. Every touch of the brush indicates a wholly intelligent purpose. The entire composition shows minute elabora-

tion, but upon the broadest possible lines. How quietly, but how wonderfully, does this picture express the idea of "all alone!" "*Sa première danse*," a charming and daintily painted canvas, depicts a dancing lesson early in the century. Very much of the effect is gained by a faithful delineation of the costumes of the period. "*Maître bébé*" is not so interesting as either of the others.

W. W. Oules exhibits two portraits. That of Cardinal Manning is a wonderful success in the direction of careful and effective elaboration. The ecclesiastical red robe and the ermine cape are difficult elements to manage in a portrait. In this instance they have been so artistically handled as not to detract from the dignity of the whole. The face is a marvel of successful modeling. This is a show portrait in the best sense of the term.

Alfred Parsons has contributed two landscapes. "*Aux bords du Shannon*" may be regarded as a successful work. The foreground has been very carefully painted, and the general perspective is good. The other canvas, "*Étude d'hiver*," is merely a study.

John R. Reid is represented by two very interesting works, "*Rivalité entre grands-pères*" and "*Sans toit*." They are both story-telling pictures. In the first, are two grandfathers showing a little girl how to look through a "spy-glass." In the second, is a family group of strolling musicians—man, woman, and child, out of luck. In each case the story is well told. "*Sans toit*" is especially descriptive; the old clarionet player looks so cold, so pinched, and unhappy; the grown-up daughter so weary and thoughtful, and her little child so timid and shrinking from the world. A lot of happy children have encountered this sad band and are looking at them with pitying eyes. In both works we have good composition and excellent *technique*.

Briton Rivière has two canvases. One, "*N'éveillez pas le chien qui dort*," is a remarkable presentation of a pair of thorough brutes—a bulldog and a brute man. The latter is *sui generis*, and can not be found in any country out of communication with the British Isles. He is sleeping with the dog—the more human of the two. But although the face of this man is in repose its lines indicate the murderer, the prizefighter, the wife-beater, and the burglar. The other work, "*Chez le magicien*," is a carefully-wrought interior, where, among other objects, we see two leopards. The picture is not particularly interesting.

J. J. Shannon exhibits a good portrait of Henry Vigne; quiet in color, dignified and natural in pose, and well treated generally.

John M. Swan has a picture of a lioness defending her cubs, treated with a very free hand. The drawing is excellent, but the tone is so dark that the merits of good composition are hardly discernible.

G. F. Watts is always an original painter. He has created a world of his own and peopled it with abnormal beings. When he has thought out a new composition, he draws from this ample store-

house and fills his canvas with his own unrealities. He seems to have a strong liking for long, nude women. They are all constructed upon the same formula, and are $10\frac{1}{2}$ heads long. In "*Le jugement de Paris*" there are three of these in a row, facing the spectator and standing (strictly) at attention. "*L'Amour et la vie*" has another. "*Hope*" is represented by a blue young woman, "doubled up," seated on the world, and nearly covering it with her ample length. "*Mammon*" is typified by a huge monster, something between a German idea of the devil and a Porte St. Martin theater stage fiend, very big and very red, sitting in a chair, with his right foot on the top of a nude manikin and another clutched with his right hand. This is a very terrible affair, and is undoubtedly the hardest hit Mammon has ever received. Four other works by this artist are exhibited. No one can question their originality.

J. McNeil Whistler is another of the world's exceptional beings. He writes, etches, draws, and paints, and was born in the United States. He has been before the world in his several capacities since 1863, and so managed his affairs as to command his full share of public attention. In relation to his art work there is the greatest possible divergence of opinion. To-day one critic exhausts the list of complimentary adjectives and high-flown terms—"art-critic" * jargon—to describe the poetry, the hidden, subtle charm, the delicate suggestiveness, the grace, etc., of his work; to-morrow, another critic, quite as well informed, will exhaust the opposite set of adjectives, and coin terms more remarkable for strength than elegance to denounce the sham, pretense, and transparent humbug of Mr. Whistler's work. Thus the doctor's disagree, and the truth probably lies somewhere between these opposite views. It may be said without hesitation of this painter that his perceptions are far from being those of the ordinary artist; that his ideas as to how natural objects should be represented upon canvas are quite his own. His work is often supremely affected, often daintily and charmingly

* A SPECIMEN.

Corot, the most exquisite of idealists, because his art is firmly based on and generalized from nature, lovingly and *endlessly observed*, may be counted among France's most truly classic masters. *There is in his best work a reticence, a gentle melancholy, not divorced from hope*, which exercises on the beholder an influence akin to that of fine Greek art; in mastery of composition, artful in its seeming simplicity, he has in France no rival; not even Claude Lorraine himself, who possessed the art but not the artlessness.

Corot did not "endlessly observe." It is a notorious fact that during the last years of his life he painted "studio" pictures and saw very little of nature. His best are consummate works of art, filled with poetic sentiment, and are often very far off from nature. But where comes in "a reticence, a gentle melancholy, not divorced from hope?"

The above is not very far away from the average art writing of to-day. For the balance of the article see New Review for September, 1889.

incorrect, and his best and most sincere productions are only suggestive of what a complete painting ought to be. It may be asserted that the majority of his efforts are suggestive conceits rather than earnestly executed work.

Among the English oil paintings Mr. Whistler has two examples; "*Portrait de Lady Archibald Campbell; arrangement en noir No. 7,*" and "*Le balcon; harmonie couleur chair et couleur verts.*" The portrait is truly Whistlerian, and in no respect satisfactory. The subject is neither walking nor standing. A rudimentary foot is shown, but it seems to be suspended from something and incapable of bearing weight; it is not an English foot, nor does it even appear to rest on anything. It is only an incorrect suggestion of a foot. The figure is top-heavy with the unpicturesque rotundity of a fur cape which gives to the subject something of the appearance of an inverted irregular pyramid. At the top of the structure is a head with no indication of a neck, and nearly the whole is an arrangement in black—or rather an affectation in various shades of dark mud. The other work is a charming conceit in delicacy of color, and graceful ease of composition. It is manufactured out of the whole cloth of the artist's imagination and makes no pretension to truthfulness. The costumes, tea tray, musical instrument, and balcony are Japanese, but the faces of the girls are English, and the tall smokestacks of Thames manufactories appear on the opposite side of the river. The picture is a singular mixture, but a most fascinating one.

WATER COLORS.

The English display of water colors is large and comprehensive, and thoroughly national in its leading characteristics, the chief of which is careful elaboration in imitation of solid oil painting. Among those whose works appear to have been executed more in accord with the generally admitted theory of what water color drawings ought to be, as practiced by the artists of other nations, may be mentioned the names of J. Aumonier, W. Langley, H. Marshall, and W. L. Wyllie. There is one work "*Un nouveau quartier de Londres,*" by Alfred East, which is of remarkable merit. It is in fact one of the best water colors in the whole Exposition.

SCULPTURE.

The sculpture exhibit of the English is not imposing. The conceptions of the English sculptors are not clearly and boldly set forth, and their subjects are complicated and difficult to understand. They are seemingly fully alive to the value of the simple Greek lines, but do not know quite how to portray them. "*Reveil,*" by Sir Frederick Leighton, is a case in point. This statue of a man stretching and

yawning has many good points illustrating action and expression, but is another very clear specimen of "attitudinizing," and very defective in its technical development. The statuette by the same artist, entitled "*Fausse Alarme*," is that of a girl looking over her shoulder with an expression of fear, the cause of her alarm being a toad on the ground. There is much that is pleasing in this work, but it does not convey the idea of great power.

Hamo Thornycroft's "*Teucer*" is serious in subject and treatment, and altogether sculpturesque. The movement is vigorous and simple, but loses in strength by sameness of values. It is, however, very interesting by its conception, which recalls the antique, and it is by far the best piece of sculpture in the English section.

ETCHINGS.

Among the fine etchings to be found in this section is to be noticed the work of Hayden, R. W. Macbeth, Short, Whistler, and others. The nine by Whistler are characteristic, that is to say, supremely airy and artistic suggestions of substantial objects. They convey an idea of uncertainty and atmosphere seldom found in such works.

GREECE.

The Greek section, including the five classes, contains ninety-one items, and with the exception of two statues, one of Paris, the other of a Greek slave, by Bounanos, of Athens, there is nothing worthy of mention. In the whole list of forty-six paintings in oil, there is not to be found a single canvas which calls for serious consideration. The two statues referred to are only fair specimens of conventional work. In the one of Paris, an attempt to produce a body after the antique is perceptible, but the head is that of an Italian officer of to-day. The decline of art in the most classic of all lands seems to be complete and final, *i. e.*, if the display of modern Greek art at this Exhibition be comprehensive and representative.

ITALY.

The official catalogue states the number of works from Italy to be three hundred and twenty-seven, but owing to mistakes of the compiler or to very late arrivals, the actual number is greater in each class. As a whole, the Italian collection is not an encouraging one, and after looking carefully through it one naturally asks, what has become of the artistic instinct of the Italians which is supposed to be so national? Has the influence of the great Renaissance disappeared and left no trace upon the later Italian artists?

The work of the present day shows neither strength of imagination, correct composition, nor dignity, and were it not for a few landscapes and a small number of figure compositions, the collection

would be hardly worthy of notice. Nothing in art could be more dreary, trifling, and devoid of interest than a large majority of the figure pieces, which as a rule, both as to value of subject and execution, do not reach above the level of the hundred thousand times gaudily painted Roman peasant, male and female, with which the world has been so bountifully supplied during the last seventy-five years. The absence of skillful *technique* is quite as apparent as are the faults of composition, and it may be said of the whole collection that if it indicates anything, it is a want of ambition, and tendency to be satisfied with very trivial results.

PAINTINGS IN OIL.

Leonardo Bazzaro, of Milan, is represented by two really strong and characteristic works. One, called "*Chioggia*," is a Venetian composition of water architecture and figures. The scheme of color is warm, deep, and strong, and the action of the women crossing a bridge is natural and easy. The other canvas, "*Couvent*," is a vigorous landscape with an old convent in the foreground. These are among the few really fine works in the Italian section.

Bartholomeo Bezzi, of Rome, exhibits a landscape, "*Les bords d'une rivière*." It is a fair example of warm color, and shows some very broad and comprehensive drawing.

Jean Boldini, probably the best known of the Italian artists of this time, is represented by nine works. Two portraits of men, one of whom is Verdi, are remarkably lifelike. That of the great composer is especially so; it is strong to coarseness, but is the counterfeit of the actual man. There are also three full-length portraits of women which are decidedly original in a certain sense. The scheme of color in regard to drapery is greenish white, and in relation to flesh, ash gray, while in each case the figure resembles in form an elongated pyramid. These portraits can not be regarded seriously, but if viewed from the standpoint of sensationalism, then success to the verge of grotesqueness is unquestionable.

Filippo Carcano contributes three landscapes. "*Lac d'Iseo*," with snow-topped mountains in the distance and a lake in the foreground, has a fine atmospheric effect. The others are "*Le coucher du soleil*," fairly well painted, with strong Italian characteristics, and "*La plaine Lombarde*," a broad and comprehensive view, but not satisfactory as to color.

Guglielmo Ciardi is represented by four landscapes, two of these, "*Torrent, vallée de Primiero*," and "*Octobre*," are of especial merit. They are faithful and picturesque transcriptions from nature, and prove that the artist is both a master of *technique* and a careful and intelligent student of scenery.

Angelo Morbelli, of Milan, has but a single work, "*Les derniers jours*," but it is one of the thoroughly suggestive works of the Exhi-

bition, and realizes much that is most simple and straightforward in art. It depicts a large room in a charitable institution for old men in Milan. The inmates are seated in long rows facing in one direction, with a most suggestive expression of waiting on all their faces—waiting for bodily sustenance, perhaps, and for the peace of death that is not far off. All the heads are carefully painted, and all express in a variety of ways the supreme thought the picture is intended to represent.

G. Muzzioli has a work which is not given in the catalogue. It contains some painting of old marbles, quite remarkable for the success with which it imitates the softness to be observed on the very ancient ones of Rome. There are two figures fairly well done, but treated in the later Italian fashion.

Luigi Nono exhibits a work called "*Fruitier*," which gives us the interior of a vegetable and fruit shop in the charge of a girl who has a younger child with her. Nothing could be more realistic than the painting of the vegetables and fruit, and the figures in the shop are as thoroughly Italian as possible. This may not be high art, but of its kind it is excellent.

Giovanni Segantini, of Milan, is a painter possessing very strong individuality. Of the three canvases he exhibits, one is a study of horses, another of cows, and the third of sheep. He draws with an exactitude seldom seen, the action of his animals is natural, and his landscape is scrupulously correct; yet with all these qualities his work does not leave much impression on the beholder. There is a certain hardness of texture that prevents it from being of the taking sort. His paintings are merely interesting examples of very conscientious work.

Adolfo Tommassi is another of the fairly good Italian artists who paint in a characteristic manner. His two landscapes are full of the atmosphere and the forms of Italy. "*Après la gelée*," is a perfectly artistic rendering of wonderful frostbitten nature. A field of withered cabbages would not in a general way affect the imagination, but here the artist has succeeded in giving them such a forlorn appearance that sympathy is excited, and one feels real sorrow for the dead cabbages.

PASTELS.

Among the pastels are two by Arturo Reitti, of more than ordinary excellence.

SCULPTURE.

Among the ninety-eight contributors to the sculpture class, there is hardly a single piece showing on the part of the artist the slightest appreciation of the dignity and grandeur of the great art adorned by the works of Donatello and a long list of illustrious Italian mas-

ters. The majority of the pieces do not reach far above the artistic standard of the trivial mantle ornaments which may be purchased in the shops of the poorest bronze founders. They have the usual embellishments, which constitute the well-known tricks of the stone-cutter's trade for fascinating the eye of those who have a taste for millinery in marble, and they ought to be set down as mere articles of commerce, and never be measured by any known standard applied to art. Exception may possibly be made in the case of two or three busts, and the foregoing statements certainly do not apply to several of the works of Eugenio Maccagnani, of Rome. This artist exhibits five miniature busts in bronze which are in perfect imitation of the Greek, but are at the same time original and strongly characteristic of the sculptor. The general handling is marked by perfect freedom from the conventional, and shows considerable aptitude for interpreting nature. It is to be regretted that his successful little studies were not enlarged to the size of life.

NORWAY.

The exhibits from Norway number one hundred and forty-three items, of which one hundred and twenty-five are oil paintings. Although the work of the Norwegian painters collectively does not rank very high when measured by the standard of what is best in art, the section contains much that is original and interesting. Even among the almost rudimentary attempts there are to be found earnestness of purpose and vigorous brush work, and the general tendency is to go very close to nature, and to imagine as little as possible.

The subjects in the story-telling works are, as a rule, selected from scenes in low life, and the point of chief interest is usually developed with simplicity and directness of aim, sometimes showing appreciation of sentiment and capacity for expressing it. The *technique* is usually coarse, but it is frequently telling and very much to the point.

PAINTINGS IN OIL.

Mlle. Harriet Backer is represented by two works. The one entitled "*Chez moi*" is a pleasant composition in gray of a young woman at a piano. It is simple and effective. The second canvas is less successful.

Jacob Bratland gives a little domestic story of parents watching over a sick child. It is earnest and true without pretension.

Jacob Gloersen contributes "*Au bois*," a very careful, strong study of a May day in the woods. The forms are well drawn and all the natural relations are faithfully preserved.

Hans Heyerdahl exhibits three canvases. His "*Soir d'été*" is a very strong and thoroughly masculine work. It has the coarse, vigorous

qualities of the north. The perspective is well managed. In "*Deux soeurs*" we have two thoroughly Scandinavian young faces, as blond and honest as possible. One is beautiful and unearthly pure, to the point of the angelic.

Mlle. Kitty Kielland has four canvases. One, "*Après la pluie*," perfectly conveys the picture of a wet bit of country after rain.

Christian Krohg is a realistic painter of stubborn facts. In his line of panels, "*Trois générations*" we see the first, second, and third of one of the rough seafaring households of the sturdy north folk. The wonderful ugliness of the old heads is depicted even to the utmost depth of the last wrinkle. They are all very interesting, but chiefly because we know that they are perfectly true. Two *genre* works are of the same character, but not so successful, for the reason that the artist tried to mix some imagination with his paint, and failed.

Gerhard Munthe is a landscape painter who can give to his works the real outdoor feeling. Of his three pictures, "*Jour d'été*" is the most successful. It depicts a scene with character, and conveys the true impression of a summer day.

Eilip Peterson is another realist who sticks honestly to nature in a coarse, strong way, but among his three pieces is one, "*Nuit d'été*," full of genuine sentiment as well as individuality.

Christian Skredevig has a large canvas, "*Le soir de St. Jean en Norvège*." In this scheme of dark green, a mountain is hiding the sun from the water, but it is not sunset. The composition is true to nature, and conveys a good idea of a late Norwegian afternoon among the mountains. "*Monte Aventino*" is a pictorial Italian architectural piece, showing a fine appreciation of local atmosphere and color, and a correct perspective. "*Une ferme à Venoix*" is a rustic piece with peasants and cows, correct, strong, and unrefined.

Fritz Thaulow is possibly the better of the living Norwegian painters. His "*L'attente*" is a simple bit of out-of-doors scenery, with a horse attached to an open wagon, waiting at a gate. It is a little subject, not particularly interesting in itself, but is treated in such a pleasant, natural way that it compels admiration. "*Hiver en Norvège*," and "*Un dimanche; après le service*," are fine examples of the successful delineation of winter scenes. We feel through them the calm, staying cold of the far north. The frostiness of the air is so perceptible that in looking at these works one is disposed to shiver. The two pastels, "*Marais*" and "*Le dégel*" are original and artistic, the latter especially so.

Erek Werenskiold is an artist of rare power over the most direct methods of expression. His "*Deux frères*"—an interior with an infant in the cradle, and an older brother sleeping in a chair near to it—is a very homely subject made interesting by artistic treatment. "*Grandemère*" is a plain, unvarnished truth. This portrait conveys

the idea of a really kind and estimable grandmother. "*Paysage*" is a very tender and truthful study from nature. "*Enterrement à la campagne*" is, like the others, a simple transcript from the actual. The newly opened grave, the reading of the last service, and the sorrowful reverence of the mourners, are faithfully depicted. All of these works are pitched in a high key of color, and the lighter tones are particularly tender and transparent.

HOLLAND.

Holland is represented by two hundred and eighty-eight exhibits, and outside of the two hundred and seventeen oil paintings there are not many works of marked merit or of special interest. Even among the oils, the work generally is not of a high order. The decadence is not so marked or so far advanced as it is in Italy, if the works now exhibited fairly represent the condition of the arts of both countries. There seems to be more ambition, more serious effort, in Holland, but it can be plainly seen that the skill which is taught by the training school is wanting. The composition of the figure pieces especially, is usually of the commonplace, book-illustration order, and the execution is inexact and unskillful. There are, however, several strong and accomplished artists among the exhibitors, and their work is worthy of consideration.

PAINTINGS IN OIL.

D. A. C. Artz is represented by three canvases. One, "*Consolation*," is fine in sentiment and well composed, but is not all that could be desired in color; the tones are not clear and decisive. The others may be passed over.

Nicholas Bastert has a large study of Autumn, very rich in color. It is not one of the gaudy autumnal pictures, for the tones are deep as well as warm. The whole is painted with a free hand.

Georges H. Breitner contributes a clever, sketchy advance of cavalry line. The movement is correct, and the general effect like the reality.

Edouard Frankfort has sent an interesting work entitled "*Une leçon du Talmud*." We have here a well drawn group of the Teacher and His followers—Jews of the intellectual sort are eagerly listening to the great history so intimately connected with their past.

P. J. C. Gabriel is an artist of rather strong individuality, and one of his three exhibits, "*Une tourbière en Overijssel*," must be representative of his better work. The ruling qualities are breadth of treatment, atmosphere, and perspective.

Joseph Israels, probably the best known as well as the most gifted of contemporary Dutch painters, exhibits three works. "*Les travailleurs de la mer*" is painted in a very large and vigorous manner. The water has the true movement of the ocean, and the two sea-

faring men, carrying the anchor and rope, are very natural figures. "*Paysans à table*" has the same sterling qualities. Sincerity and a fine appreciation of color are strong elements in the works of this painter.

Frederic H. Kraemmerer is a Dutch artist who has painted in Paris for many years, and his works are so well known that any description of them would be superfluous here. It will be sufficient to say that they are costume, incident, and character pictures of the French revolutionary period: and treated as he treats it, it may be said that he has had the field quite to himself. He is entitled to the credit of having vividly recalled the dress, the grotesque vagaries, and the follies of a most extraordinary period.

Two works by Henry Luyten, "*Déjeuner d'ouvriers*" and "*Une séance de si je puis*," show greater facility for composition than capacity for correct execution. The paintings, however, are meritorious and not without interest.

The five canvases by Jacob Maris indicate considerable capacity in several directions. In landscape and architectural painting he is equally at home, without being great in either. He sees nature with the eye of a true artist, and usually succeeds in avoiding the error of overelaboration; but his finished pictures are uneven. If he succeeds in tone, he fails in perspective, etc. The best of his five pieces is "*La vieille bonne*," which is well composed and strongly painted.

Anton Mauve, who died in 1888, is represented by five works, all painted with a free hand. The forms are sketchy and light, very artistic in touch; the color is tender and truthful. The work entitled *Bruyère* is of marked excellence, something in the style of Michel, but freer in the drawing.

Hendrik Willem Mesdag has the quality of individuality more marked than any other Dutch painter of his time. His works are, so to speak, signed all over, so as to be quite unmistakable. "*À l'ancre*" and "*Marée montante*" are good examples of strong, sober painting. In the first, the floating ships are remarkably drawn. In both the perspective and tone are excellent. The third, "*Nuit au bord de la mer à Scheveningue*," is a moonlight scene of exceptional interest. It has the merit of successful perspective, such as is seldom equaled in the treatment of this aspect of nature, so difficult to paint.

Albert Neuhuys is a *genre* painter. He is represented by five works. In the scale of art they do not rank very high. They are somewhat original, fairly composed, but indifferent in execution. The best of the number are "*Le cordonnier du village*" and "*Moments de peine*."

Willem Roelofs is a delineator of Dutch scenes, which he treats with considerable success. Of the three now exhibited, "*Polder à Noorden en Hollande*" is the most complete and artistic both as to

drawing and color. The prevailing tone is gray, but more transparent than the usual gray of continental painters.

Mlle. Therese Schwartz is a young artist of much promise. She has undoubtedly a fine instinct for color and artistic pose. Of her three canvases, her portrait of herself in working costume is by far the best. It is original, broad in treatment, and must be a strong likeness.

WATER COLORS, ETCHINGS, AND DRAWINGS IN BLACK AND WHITE.

Among the water colorists and workers in black and white, may be mentioned the names of Bock, Bosboom, Cate, and Weissenbrach, who are represented by fairly good contributions. Among the Dutch etchers whose work is far above the average, may be found the names of Vith, Witsen, and Zilken.

SCULPTURE.

There are only two pieces of sculpture in the Dutch section; both are uninteresting.

RUSSIA.

Of the two hundred and five works contributed by Russian artists to the various classes, one hundred and forty-six are oil paintings. It can not be said of the whole collection that it takes a high place among those of other European countries. While it includes a few works of considerable interest, and decidedly meritorious from an art standpoint, it must be acknowledged that the majority rise only to the level of commercial commonplace, and if artistic at all must be regarded as belonging to the category of the ornamental rather than the intellectually aesthetic. Careless and incorrect composition clearly proving the want of intelligent appreciation of the forms and resources of natural objects, and the absence of skillful *technique* are plainly observable in many of the works of the Russian painters in oil.

PAINTINGS IN OIL.

By the death of Mlle. Marie Bashkirtzeff not only her own country but the world of art sustained the loss of a unique character. She was a painter of much promise, possessing the art instinct to a wonderful degree, and being especially endowed with the faculty of reproducing the expression of the human face. Her ten works now exhibited afford ample evidence of this. The "*Portrait*," "*Sous le parapluie*," "*Pierre et Jacques*" (two boys on their way to school), "*Le rive*," in three panels, showing an infant, a girl of ten, and one of sixteen, each in the act of laughing, prove that the artist's success with commonplace subjects is to be summed up in three words—truthfulness, directness of purpose, and simplicity of execution.

"*Un atelier de peinture*" shows, like the others, the perfection of honest endeavor and appreciation of natural forms.

Joseph Chelmonski is an artist of prodigious individuality of the right sort. He rejoices in painting the peasants and horses of his country. His "*Marché aux chevaux*" is as national as possible, that is to say, thoroughly Russian. The atmosphere, the rush of the magnificent horses full of splendid action and animal life, their keepers, and the groups of buyers and sellers bargaining, are all faithfully spread before us. "*Un dimanche en Pologne*" is a work of rare strength and originality. In this scene of peasants junketing out of doors are fully depicted the robust, boisterous, and rude pleasures of an untutored class who hold on to the old manners and customs of their ancestors. In this composition it is difficult to decide which to admire most—the wonderful scheme of deep, strong color, the grouping of the figures, the action, or the sky or landscape. The artist is one of the very few who have mastered the extremes of physical action. The movements of his men and animals always seem to be perfectly natural, whereas in the works of other artists they are often forced and grotesquely exaggerated. His two other paintings are fit companions to those above described.

Jean Endogouroff contributes a canvas depicting a very cold Russian night, with a good perspective, which in such works is rare. Two others, "*L'Automne en Crimée*" and "*Le soir*," are well composed and very characteristic of the painter.

Alexis Harlamoff is an artist of some individuality, and his work is of the pleasing order. He has facility for producing agreeably decorative effects of color, but the power of composition is not his. Of his eleven subjects, seven are entitled "*Tête d'enfant*." They may have been intended for different infants' heads, but they are substantially alike. In position, costume, color, etc., they scarcely differ one from the other.

Samuel Hirszenberg is represented by a very dark interior, containing a well composed group. It is a serious attempt to illustrate the intellectual side of the Jewish character.

Kouznetzoff, of Odessa, contributes one work, "*Devant l'autorité*," a characteristically Russian scene. An official, in an open carriage with attendants, is listening to the complaints of a group of country people. The composition is pictorial, and character is well depicted in the different faces.

Georges Lehmann is a portrait painter, and three of his six works exhibited are portraits. One of his canvases, "*Dame; sous le Directoire*," is noteworthy on account of its original and artistic treatment. It might be termed a study in blue, that being the dominant color. The composition is taking and graceful and the *technique* is skillful.

Constantine Makouski is an ambitious and inventive painter, but he has not sufficient grasp of *technique* to give adequate expression

to his creations. His large canvas "*Jugement de Paris*," is pitched in a very high key of color, is purely decorative and conventional, but has some rather artistic and graceful details. His "*Mort d'Ivan-le-Terrible*" has, in regard to color, all the qualities of the chromo. His five exhibits afford convincing evidence that he would rank well as an artist if he only knew how to *paint*.

Joseph Pankiewicz exhibits one work, "*Marché aux légumes; Varsovie*," which is a vividly realistic picture of a vegetable market, with figures exceedingly characteristic of the place and people; but the subject appears to be hardly worth the labor bestowed upon it.

Ivan Pranishnikoff contributes nine small works in oil. This artist has a sense of the beautiful in composition and color. His faculty for construction enables him to make a thing of conventional beauty out of the most commonplace natural objects. His forms are light and graceful, and his colors conventional but warm. His work is notable for the qualities which generally please. It is rather singular that some enterprising dealer has not started a specialty under the name of "The Pranishnikoff gems."

Swiedomski, of Kieff, is represented by a very large canvas, "*Épisode de la Terreur*." It is a very spirited composition. A crowd of wild revolutionists, of both sexes, armed, and wearing the florid dress of the period, rushing away from a broken carriage and the body of a beautiful woman whom they have murdered and left upon the road. The story is vividly told, and recalls the terrible period of which this scene is only an "episode."

Vinceslas Szymanowski proves conclusively by his single picture, "*Rixe de montagnards polonais dans un cabaret*," that he is an artist of unusual power. For color, drawing of the human figure, facial expression, and natural action this work is truly remarkable. All that is involved in a peasant's quarrel—energetic gesticulation, infuriated faces, involuntary movements of anger, violent language—is forcibly expressed, without exaggeration. The masterly composition of this large canvas compels attention.

WATER COLORS, PASTELS, AND DRAWINGS.

In class 2, water colors, pastels, black and white, etc., there is some very good work by Adalbert Gerson, Pranishnikoff—who contributes much that is varied and in his best vein—Samokich, and Pierre Sokoloff, whose large water color of "*Marché aux chevaux*" is most noteworthy. The composition is true to nature, and great skill is shown in the execution.

SCULPTURE.

The Russian sculpture is not strong either in quantity or quality. It can not be said to bear any national impress, but here and there slight indications of French and Italian influence are discernible.

Pierre Tourguéneff contributes the only piece worthy of special notice, "*Pastour de la Steppe*," a life-size equestrian statue, is a very interesting, calm, and earnest work, with a certain amount of character. "*Fille d'Eve*," a marble statue, represents a woman lying at full length in a lazy, negligent attitude. It is a good study of the female form, and is certainly pleasing. These and other works exhibited by this artist are serious and unpretentious.

SWEDEN.

Sweden contributes two hundred and twenty-eight works to the Exhibition of Fine Arts. One hundred and fifty are oil paintings. This collection, like others furnished by nations of the north, is characterized more by rude strength than by picturesqueness or beauty. It is quite apparent from their productions that the Swedish artist has accepted the theory that has been too generally adopted, that art should have as little to do with the development of the beautiful as possible, and that those who practice it should content themselves with delineating in a mechanical and matter-of-fact way just what they see in nature and nothing more.

There are, however, among the works in this section several which show not only excellent *technique*, but go very much beyond in the way of harmonious composition and fine suggestions in color, skillfully and artistically set forth.

PAINTINGS IN OIL.

Richard Bergh, an artist of marked ability, is represented by five works. He shows to most advantage in his three portraits, which betray a decided individuality in the direction of the best methods of portraiture. Simple and unpretentious, they show the character of the subject. His "*Paysages*" is suggestive, sketchy, and true, and proves this painter to be a master of more than ordinary merit in the field of landscape.

Nils Forsberg has sent a single picture, "*La fin d'un héros; souvenir de 1870-'71.*" It is large and serious in composition, and may be regarded as a fairly successful effort to commemorate a typical scene, the death of an officer from wounds received in battle.

Auguste Hagborg is probably the best known of all the living Swedish artists, and his works are justly esteemed for their many fine qualities. He is represented at the Exhibition by eight canvases, in which his manner of treatment and style of composition are to be easily recognized. His earlier works are noted for their fine, clear, atmospheric effects and strength of drawing. A well defined purpose, combined with a just appreciation of forms, ran through them. The pictures by which he is now represented do not exhibit the fine qualities of the artist so strikingly as did those of former days.

They leave an impression of having been rather carelessly painted. The sparkling, clear grays have become almost white, and the transparent atmosphere, once so much admired, has become opaque and uncertain.

Ernest Josephson is represented by seven works. One, "*Portrait de M. R.*," is of decided excellence, both as to quality of color and execution.

Carl Larsson shows one work, an extraordinary scheme of decoration. It is a composite of plaster and canvas, forming three panels, and intended for a private gallery at Gothenberg. The triple subject is "*La Renaissance; le XVIII^e siècle; l'art moderne.*" The principal figure is enthroned in the midst of others, which are very long, badly modeled, and faulty in drawing. Some of them are sprawled out in most ungraceful positions. The whole composition is a confused mass of lightly colored and plaster human figures, carrying no intelligible meaning. But the work must be of considerable art value, otherwise the International Jury would not have given the artist a first medal for its production.

Bruno Lilijefors is a painter of animals. Two of his four works in the Exhibition, "*Chasse aux canards*" and "*Chasse finie*," are vigorous. The first mentioned is very truthful, freely handled, and strong in perspective. In the other the action and expression of the dogs are particularly spirited and natural.

Of the two pictures shown by Allan Österlind, "*Le baptême*" is the better. It is composed of landscape, architectural features, and children, for it is somewhat in the vein of the children's party by Knaus, although in no respect an imitation.

Mme. Hanna Pauli-Hirsch has sent three works. The "*Portrait de Mlle. V. S.*" is artistically much better than the average portrait, and probably possesses the additional merit of being a truthful likeness.

Hugo Salmson is an artist of considerable invention and facility for composition. He has a weakness for French peasants, and paints them very prettily. Two of his pictures, "*Une arrestation, Picardie*," and "*A la barrière; en Suède*," were purchased by the French Government and form part of the Luxemburg collection.

Alfred Wahlberg, another of the well-known Swedish artists, has sent seven works, "*La lune de Septembre à l'île de Väderön, Suède*," and "*Soir du mois d'août à Lysekil; Suède*," bring the scenes which they represent vividly before the spectator. The former of the two is exceptionally strong and clear in color.

Anders Zorn exhibits his vigorous painting "*Un pêcheur*," loaned by the Luxemburg gallery, and two lifelike, broadly treated, decorative portraits.

WATER COLORS AND PASTELS.

Carl Larsson is a water colorist who uses his brush with rare facility. He contributes four works. One of these, "*Le Vin*" is in two parts. In the first is a young woman picking grapes under a trellis, and in a second an old man is drinking wine. The first is a most delicate scheme of light green and yellow. "*Jour d'Automne*," is also very pleasing in color and altogether artistic.

Robert Thegertröm has two pastels. "*Le soir au village*" has a charmingly soft atmosphere, and is artistically composed.

Alf Wallender is a pastelist possessing rare power of observation and directness in expressing his ideas. He contributes five works, "*Pauvreté*," "*Intérieur d'un cabaret*," "*Deux amis*," are all story telling delineations, full of merit and interest. This artist has found out how little material it takes to make a good picture, if that little is well done.

Anders Zorn exhibits five water colors. "*Portrait de Mlle. S.*," "*Enfants*," and "*Deux filles*," are very sketchy and lightly handled.

SCULPTURE.

Pierre Hasselberg is the only Swedish sculptor whose works in the Exhibition appear to be of special interest. Two of them, "*Attrait de la vague*," and "*La petite grenouille*," are well modeled, and are serious attempts in the direction of truth.

SWITZERLAND.

Switzerland contributes one hundred and sixty-eight items to the Exhibition of Fine Arts. Among the oil paintings are to be found several that are remarkable for their robust strength and want of pictorial grace and interest. These works of art seem to partake of the ruling characteristics of the Swiss people. They are matter-of-fact in composition, rude and coarse in execution. As a rule they are not the kind that give pleasure, although they may excite curiosity.

OIL PAINTINGS.

Baud-Bovy is represented by four works. "*Bergers de l'Oberland s'exerçant au jeu de la lutte*," shows two stalwart peasants wrestling among cattle, in the high mountains. There is a certain strong, rugged fidelity to nature in the composition, but it is totally devoid of the imaginative, and would do well for the panel of a beer shop. The three other works are of the same order.

Earnest Biéler exhibits among his three canvases a large one representing a life-size group of peasant women standing in front of a church. They are painted as though they were made of blue and green porcelain, and standing upon a grass plot composed of bits of broken green glass. This artist, like the Impressionists, has made a

bold dash for something new, and has not been unsuccessful. His work is possibly an artistic curiosity.

Louise Breslau contributes four oil and three water colors, and in each there is clear evidence of the true art instinct and its cultivation in the right direction. The large portrait of herself is the most original and cleverly executed work in the Swiss collection.

Eugene Bernand is probably the most successful painter of Swiss farms, bulls, cows, sheep, etc. His three representative works now exhibited belong to the three most important collections of his country. This is sufficient evidence that his pictures are greatly appreciated by his countrymen.

Jules Giradet is a painter of war scenes. Two of his four works now exhibited, "*La déroute de Cholet*," and "*Le Général de Lesclure blessé, passe la Loire avec son armée en déroute*," are very spirited; the former is particularly full of action, and betrays a fair knowledge of the real movement of a war episode. In both canvases is to be perceived a serious attempt to master a difficult subject, and in each instance a fair amount of success has been attained.

Charles Giron is represented by three portraits and one of the largest canvases in the whole Exhibition. It is called "*Les deux soeurs*," and tells the old story of poverty on foot, the good sister in coarse garb, with small children in hand, while the very bad sister, dressed in costly laces and fine silks, rides in a luxurious carriage. The scene is in Paris, just in front of the Madeleine, where (in the painting) vehicles of several sorts are involved in the greatest confusion, omnibusses being driven over the steps of the church, etc. Notwithstanding the defects in drawing and perspective, the painting tells its story in an exceptionally strong manner, but without the moral, for the bad sister does not seem to suffer any considerable amount of visible punishment on this earth for her sins, and for all we know she may be sharp enough to repent in time to save herself trouble in the next. The central group (the two sisters and the carriage) is remarkably well done.

Edouard Ravel's "*Fête patronale dans le Val d'Hérens*" is a scene of peasants in a church porch among the mountains. It is rather better than such compositions usually are. The other three works by this artist are not of much interest and do not call for special notice.

Alphonse Stengelin contributes two pleasing landscapes, simple in design and general treatment, but executed with great care. "*Environs de Laaghalen, Hollande*," is especially attractive on account of its truthful, serial perspective, and fine tree forms in the middle foreground.

The other classes introduced in the Swiss section do not contain works of marked merit, nor do they present any peculiarities which need be dwelt upon.

OTHER STATES.

In addition to the countries already mentioned as exhibiting in the *Palais des Beaux Arts*, Roumania and Servia sent small collections of little artistic value.

THE INTERNATIONAL SECTION.

In the rooms set apart for the works of artists of various nationalities which arrived too late to be placed in the sections to which they belonged, a small number are of considerable merit. The works of the following artists are especially noteworthy: Arturo Michelena, of Venezuela, J. J. de Souza-Pinto, of Portugal, Thompson, of England, and Zackarie Zakarian, of Constantinople.

The Principality of Monaco, the Republic of San Marino, and Hawaii, the Argentine Republic, Bolivia, Chili, Ecuador, Guatemala, Salvador, Uruguay, and Mexico have their art exhibits combined with their industrial sections. With the exception of the pictures of Vilasco, the Mexican artist who paints the scenery of his country with ability, there is nothing that is really noteworthy in the art work contributed by these various states. The condition of art in Central and South America can not be very flourishing, if the examples set before us in the Exhibition are to be taken as a criterion. Viewed collectively, they show neither schooling nor ambition. The subjects chosen are, for the most part, trivial, and both in composition and execution they leave a good deal to be desired.

THE FRENCH WATER COLOR SOCIETY.

The French Water Color Society exhibits four hundred and sixty-three noncompetitive works, in a separate building near the *Palais des Beaux Arts*. They show a very marked falling off. During the first years after the organization of the Society of French Water Colorists, each annual Exhibition was a notable event. Only a small number of artists exhibited, but as a rule their works were of true excellence. While there are a few good examples in the present collection, it must be admitted that the large majority are in no sense representative of the best methods of water-color painting.

THE FRENCH PASTELISTS.

The French Society of Pastelists likewise occupy a separate building. It is near that containing the water colors, and includes one hundred and fifty-three works. Of the collection it may be said that it is representative of its kind, but while it leaves an impression of good artistic qualities, it does not seem to be of particular interest as a whole. The list of exhibitors contains some of the best known names connected with French art of to-day; but the work generally appears to have been done as a pastime in the leisure moments of the artists, rather than in their serious hours.

ARCHITECTURAL DRAWINGS.

In the competitive part of the Exhibition of Fine Arts are "Designs and Models in Architecture." Some three hundred exhibitors have contributed about fifteen hundred drawings. In this class France clearly takes the lead both in variety of invention and in execution. Many of the drawings, showing the restoration of the famous Greek temples of antiquity and some of the more historical buildings of the later Roman period, are notable as evidences of scholarly research and fine workmanship. Such work enables us to realize, as none other can, the glorious architectural achievements of the ancient civilizations. In the number of exhibits England comes next to France, but her work does not compare in merit with that of the French. The English exhibitors show no love for the noble Greek prototypes. Their country seems to be the hospitable home for every phase of the composite in architecture. The Dutch collection stands next to the English in importance. Several other countries show from one to sixteen numbers, presenting nothing more remarkable than fair office work.

GENERAL REMARKS.

The foregoing remarks close this report so far as it relates to the exhibition of contemporary art. The writer has sought to draw attention to the better known artists, and those of acknowledged superiority, representing every country, and especially to indicate the work of those who appear to him to be on the right path. If his descriptive or critical remarks have any practical value, it must be in so far as they may assist the reader to form some impression of the contemporary art movements throughout the world. The very large number of works exhibited has rendered the task of mentioning even the names of all deserving artists one of great difficulty, which for many selfevident reasons the writer did not attempt to complete.

THE RETROSPECTIVE EXHIBITION OF FRENCH ART.

A very attractive, instructive, and possibly in several respects, the most important portion of the Fine Arts section of the Exhibition, was the "*Exposition Centennale de l'Art Français (1789-1889)*." This collection was composed of oil paintings, 652; drawings and water colors, 558; miniatures and fans, 76; sculptures, 140; medals, 129; architectural drawings, 376; engravings and lithographs, 465; total, 2,396.

These several classes forming the retrospective collection, were arranged under and in the immediate vicinity of the "*Dome*" of the "*Palais des Beaux Arts*." The sculpture on the ground floor, and the exhibits forming the other classes in the galleries of the second

floor under the dome, and extending into and occupying several large galleries adjoining.

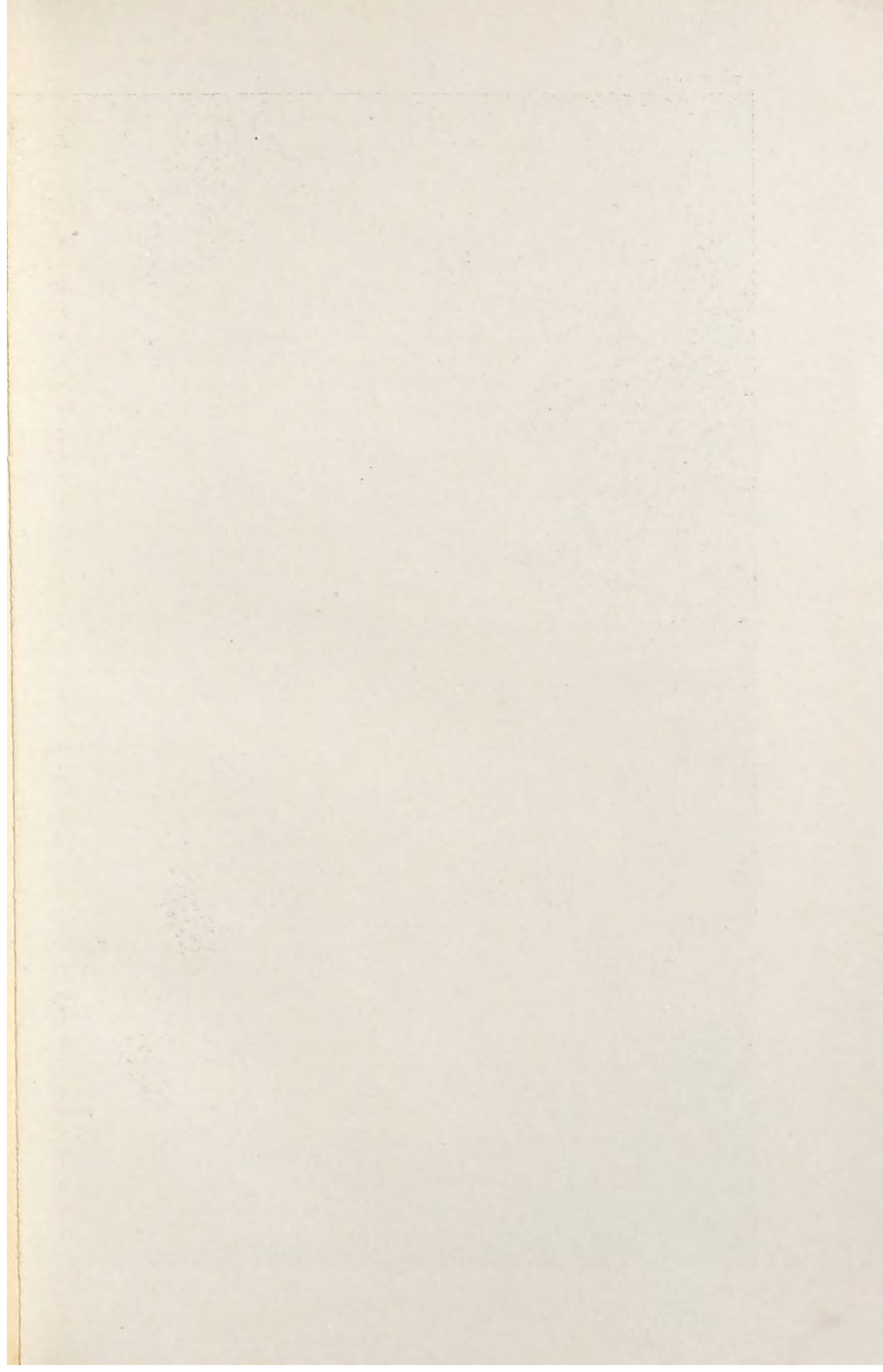
THE DOME.

The dome which crowns the center of the Palace of Fine Arts is one of the most beautiful structures of its kind in existence. Artistically poised upon slender and graceful supports, jauntily lifted into the air, seemingly without effort, lighted from four sides by four long windows located immediately under the spring of the dome, as well as from the top, and delicately and artistically decorated in imitation of light tile work, it is like a dream of architectural abstraction, novel in design and construction, and fascinating in all the details of its adornment. It became at once a leading attraction and a distinctive feature of the Exhibition, and when regarded in connection with the historic and beautiful objects it partially covered, its powers to fascinate the sense of the beautiful has seldom been rivaled. Its decoration is so effectually illusive that the unsympathetic surface of the iron and glass with which it was constructed are completely subordinated to an exceptional triumph of art over the most belligerently inartistic combination of building materials known. It may be said of the whole group popularly known as the "Main Buildings" of the Exhibition, and constructed of those materials, that it is the only iron and glass structure on a large scale, which, from an aesthetic and architectural standpoint, ought to be permitted to exist.

While the retrospective collection was not as to important names quite complete, it was comprehensively illustrative of the preceding century of French art, the merits and demerits of the century's work were fully set forth, and never before was there such a compact opportunity for studying the varying phases of national characteristics and fashions in all branches of a national art.

OIL PAINTINGS—DAVID—MANET.

The oil paintings represented one hundred and thirteen deceased, and seventy-six living artists. The two extremes of the century were seen in the works of David and Manet. The carefully constructed compositions of the former prove that he knew the value of Greek forms, and that he was imbued with the poetic spirit which animated the great masters who gave the world its finest examples of classic art. The latter was the master of a very free hand, and a believer in the largest liberty, who acknowledged neither the restraints of any known *technique* as taught, nor the obligations imposed by nature, and his works prove that he was governed by an abiding faith in methods that had, at least, the virtue of being his own. To the large majority of individuals however, of average culture and understanding, the greater part of his work is incom-



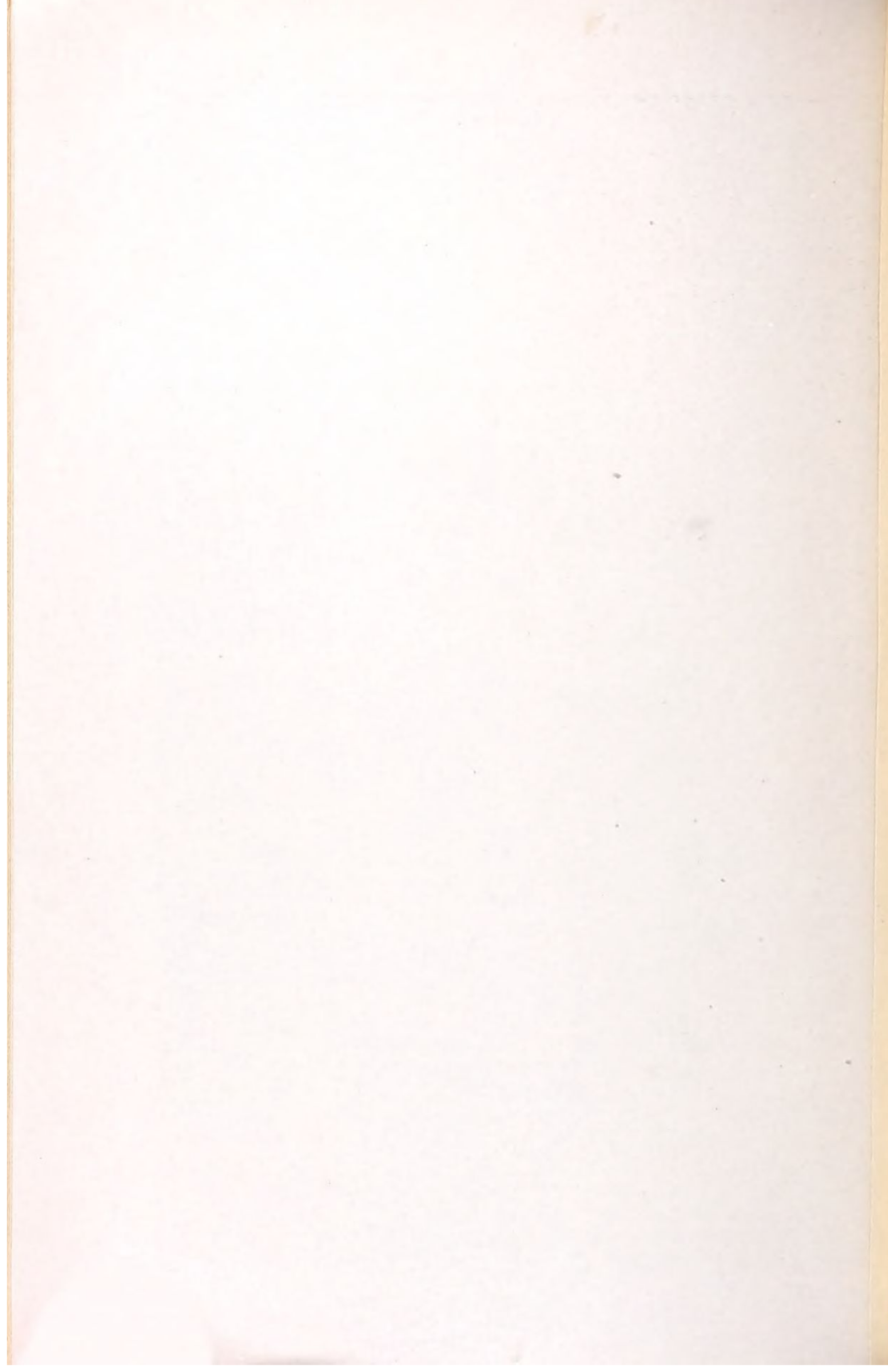


Reuillon, Vigneron, & Co.

DOMES OF THE PALACE



CE OF FINE ARTS.



prehensible, while to others a hidden purpose of great artistic import is discovered in the least important of his productions. It may be said of his reputation that it is based upon and measured by the strength of his originality and boldness as an irreverent innovator, rather than upon the real art value of his work. To this assertion there are exceptions. As in the history of all known exceptionals, so it is with this one. Sometimes from out the depths of their mysterious imaginations and methods there comes a simple manifestation of straightforward individualism that all can understand. In this instance one of the exceptions exhibited was a painting entitled "*Le Bon Bock*,"—Catalogue number, 489. It is a portrait of a happy specimen of humanity who knew the value of beer and tobacco. This presentation is in a vein quite the artist's own, but without affectation or exaggeration, and is so true and suggestive of a type that it would lose nothing of its merit by being hung in company with the characteristic work of Hals and other great Dutch artists who painted the beer drinkers and smokers of their times.

DAVID.

David was born in 1748, studied under Vien, the director for many years of the French Academy at Rome, and was one of the best among the French painters of that period of mannerisms. In 1772 he gained the second prize at the Royal Academy; in 1775 the grand prize, and with it a pension which enabled him to go with his master to Rome, where he devoted himself to the study of the antique and historical painting. In 1780 he returned to Paris and three years after was appointed painter to the king. In 1784 he returned to Rome and in that year painted for Louis XVI the "Oath of the Horatii," and finished his "Belisarius;" in 1787 he executed the "Death of Socrates," and in 1788 his "Paris and Helen." In 1789 we find him again in Paris, an ardent believer in the new order of things, and the chief art promoter of the revolutionary fêtes and monuments. The works completed previous to the revolution are regarded as the greatest of his first or purely classic period, and their execution stand for an important landmark in the history of modern French art.

It will thus be seen that his commanding position had been assured before the breaking out of the great movement which was to annihilate the power of a royal family, and build anew an old nation. It was from this last-named period to 1889, inclusive, that the late retrospective exhibition was intended to cover, or in other words, the one hundred years of a national life under the new order.

The talent of David as displayed in his works, and the debt that modern art owes to his influence in the right direction, are the excuses for the frequent reference to him in this communication.

LATER FRENCH PAINTERS.

Between the extremes of the classic style of David and the iconoclastic deviations of Manet, there was a wide field which has been covered with infinite skill by artists of marked individuality, masters of *technique* and the art of picturesque composition. But in this report it is only possible to mention the names of the more conspicuous among them, who, since the culminating point in the career of the founder, have accomplished so much for the present ascendancy of French art. There is no pretense that the list is complete, as it contains only the names and dates of birth of prominent artists, whose reputations for good work have been recognized and fully established in the later history of art. Among the names of those deceased are to be found :

Drolling.....	1732	Isabey.....	1804
Lebrun, Mme.....	1755	Diaz	1808
Vernet.....	1758	Troyon.....	1810
Watteau	1758	Rousseau, T.....	1812
Prudéhon.....	1760	Millet	1814
Girodet.....	1767	Muller.....	1815
Gerard.....	1770	Couture.....	1815
Gros	1771	Daubigny, C. F.....	1817
Guerin	1774	Courbet.....	1819
Ingres.....	1780	Fromentin	1820
Coignet	1791	Cabanel.....	1824
Géricault.....	1791	Brascassat.....	1824
Corot.....	1796	Baudry....	1828
Delaroche	1797	de Neuville.....	1835
Delacroix.....	1798	Regnault.....	1843
Déchamps.....	1803	Bastien Lepage.....	1848
Dupré.....	....		

Among living artists whose works have attained a high standard of excellence, which is generally admitted by writers and connoisseurs, may be mentioned the names of Bonheur, Bonnat, Bouguereau, Breton, Carolus-Duran, Cazin, Chaplin, Collin, F. Cormon, Dagnan-Bouveret, Detaille, Duez, Français, Gerome, Gervex, Harpignies, Herbert, Henner, Humbert, Laurens, Lefebvre, Lhermitte, Luminais, Maignan, Meissonier, Morot, Pelouse, Pointelin, Puvis de Chavannes, Roll, Tattégren, Weber, Ziem, and Zuber. Many more names might with propriety be added to each class, but a sufficient number has been cited to give the reader some idea of the masters amongst the French painters who have made notable reputations during the preceding century.

WATER COLORS AND DRAWINGS.

The water colors and drawings were especially interesting and possibly more distinctively characteristic as to nationality, than any other portion of the retrospective display. This suggestion is par-

ticularly applicable to the works of the illustrators and caricaturists of the past, which in most instances possess a pure national flavor coupled with the individuality of the artists. Their powers of exaggeration sometimes falling only a little short of the grotesque, and often going beyond, enabled them to send their arrows of satire through the thin coverings of folly, vice, and crime in a manner peculiar to themselves and beyond the power of imitation by others. The old water colors, as to distinctive characteristics, were quite by themselves and unlike any similar work by the artists of to-day, and were chiefly interesting from an antiquarian standpoint, as illustrating the styles in vogue a half a century and more ago. The better known artists represented by works in this class were Barye, Baudry, Boilly, Coignet, Courbet, Couture, Daumier, David, Decamps, Delacroix, Dutertre, Fragonard, Garvarni, Gérard, Géricault, Grandville, Ingres, Isabey, Johannot, Millet, de Neuville, Prudhon, Regnault, A. Vernet, Watteau, and others quite as well known.

SCULPTURE.

The collection of exhibits in the retrospective representing French sculptors, although not extensive, was of marked interest and almost as national in its leading features as either of the other classes. Much of the work was strongly individual, even the purely academic examples of the pronounced formalists was positively national in its treatment and expression, so much so that it could never be mistaken for other than French work.

HOUDON.

Standing out by itself and quite alone in the strength of its modest simplicity, was the work of Houdon. His three busts, Franklin, Lafayette, and Napoleon, fully attested the rare faculty of this artist for delineating the character of his subjects. In the presence of these works, while contemplating their simple lines and careful construction, we feel perfectly sure of their exceptional value as truthful portraits. Upon the invitation of Franklin, this artist visited America and executed, from life, a full length statue of Washington, which is now in the capitol building of Virginia at Richmond.

MEDALS.

The number of medals exhibited was insignificant, and did not represent the last one hundred years of French effort in the direction of representative medallic work. Many of the greatest names were missing from the catalogue, and of those present only a small number are recognized as masters. The leading feature in this class was the proof portraits, which were of exceptional merit as to design and execution. These could have been supplemented from out the great

resources of the "Hotel des Monnaies," and a collection brought together worthy of the occasion and the nation that stands at the head in this particular field.

ARCHITECTURE.

The architectural drawings by fifty-one deceased and twenty-six living architects covered a period from the time of Brougniart, Casas, Fontaine, Baltard, and Percier to the present. Although not as extensive as the collection of architectural drawings in the competitive part of the group, it was more interesting, and for the same reason which applied to the other classes of the "Centennale." It gave those interested in modern French, or we might almost say national, architecture an opportunity to study past fashions and the capacity of architects for purely artistic work. It enabled them to observe intelligently the growth and gradual crystallization into present styles and forms of the various kinds of prevailing French architecture.

Many of these drawings in black and white and in water colors displayed a rare knowledge of purely technical drawing, and, in several instances, the poetic instinct for the beautiful. But it is quite certain that very few, if any, of the works in the old collection could, as to artistic excellence in execution, be compared with the better of those in the competitive collection by living architects.

ENGRAVING AND LITHOGRAPHY.

Under the title of Engraving and Lithography there was an exceptional display of old and new impressions. Very much of the meritorious work was by artists now living, and the better of all was the etchings which formed a conspicuous part of this class. The specimens displayed proved conclusively that several of the great painters were experts in the use of the etching needle and graver. It would have been difficult to have selected a single number from their exhibits which would not stand the test of sound, critical examination. Where there was so much that was good, it would be futile to attempt even to point out the best from among the numbers conspicuous for excellence. In this list of contributions by living artists, remarkable for their fine qualities, were the works of Bonnat, Flameng, Achille and Jules Jacquet, and Meissonier, which in several instances were veritable monuments of their kind.

Among the deceased artists whose work worthily represented their reputation were to be found the names of Bonvin, Corot, Daubigny, Decamps, Delacroix, Jacquemart, Manet, Proudhon, and T. Rousseau. Others not so well known, but of equal merit, were fittingly represented.

After the etchers came a long list of engravers and lithographers. A considerable portion of this work was devoted to designs by past

caricaturists and illustrators; and from an art standpoint much of it was very poor "stuff" but not uninteresting. The old colored lithographs carried the memory back to the beginning of the flash and florid in the advertising of quackeries; and the work of the illustrators recalled to our minds the early editions of Sue, Dumas, Balzac, and a host of other popular French authors of forty and fifty years ago; while the comic genius of the caricaturists, united with a rare combination of natural instinct for satire, brought graphically to the mind of the spectator the follies and vices of French social life and much of the political intrigue which has taken place in France since the days of the revolution.

REMARKS AT END OF TECHNICAL REPORT.

The preceding paragraph brings to a close the portion of this report specially devoted to the art collections known in official language as "*Groupe I*," displayed by themselves in the "*Palais des Beaux Arts*." The notes upon which its descriptive and critical remarks are founded were taken at odd times while the Exhibition was in progress and when the writer was actively engaged in other official duties that occupied the better part of his time, and are necessarily incomplete.

It now goes to its official destination without apology for its shortcomings or excuse for the, in many instances, strong phraseology employed to express decided opinions. There is no pretense that many of the unpopular sentiments expressed or judgments pronounced as to the merits of the works of certain artists are correct. For them the claim of infallibility is not made, but they have at least the single virtue of expressing the unqualified convictions of one who has traveled much, seen very much of the world's better art, and has tried to profit by his valuable opportunities. It is, however, a matter of regret to the writer that he could not bring to the performance of his duties, critical and literary, the technical knowledge possessed by those who practice the arts, coupled with the style and literary ability of the accomplished writer.

Through the whole of this report two leading considerations have been kept steadily in view—the exaltation of simplicity and truth and the unqualified condemnation of the meretricious. In our country the absence of the two former qualities and the ever-present abundance of the latter constitute sins of omission and commission of great magnitude, which can only be corrected by the very slow process of national education; and if it shall turn out that only a small number of individuals after reading this communication shall start out to find for themselves the great truths which are manifestly applicable to the arts, the writer will feel that his labors were not without useful results.

METHOD OF SELECTING THE ART EXHIBITS.

At the time of accepting the appointment as the official head of Group I, I was aware of the difficulties I would have to encounter and had some little conception of the obstacles that would present themselves as stumbling-blocks in the road to success, and from the first had determined, as far as possible, to sink my individuality in favor of those (the artists) most interested, and after considerable deliberation with others, fixed upon the plan of selecting a jury from among the members of the National Academy of Design and the Society of American Artists, and the seventeen who were selected for this duty were taken from names recommended by the officers of these organizations. Early in the spring of 1889, and before action had been had in New York, the American artists living in and near Paris held a mass meeting and appointed from among themselves a jury of seventeen to make selections from among the works of American artists living abroad, and both in New York and Paris these bodies were intrusted with the power of selection and rejection. It may be mentioned that the exhibits accepted in each city were about one in three. The work of choosing on both sides of the ocean was performed in good faith, without fear or favor, and all errors were on the side of mercy. For it is a fact that at least fifty oil paintings were admitted which were of no advantage to our art section, and were calculated to belittle the value of the better work and to mar the *tout ensemble* of the whole.

INDEPENDENT HEAD FOR ART DEPARTMENT.

In the great exhibitions held abroad it had been, I believe, customary to make the Fine Arts a separate department, kept distinct from the other sections and under the direction of an independent head. M. Antonin Proust was the late special art commissioner appointed by the French authorities, who had sole charge of Group I, and I am certain that the wonderful success achieved in that group was largely due to the fact of the untrammelled and independent action of that official, and I know that several art sections of other nations were under the control of persons independent of any official connected with other departments, and I am perfectly certain that it would always be for the better interests at least of the arts when brought together for exhibition, that their supervision should be in the hands of an entirely independent official, and I unhesitatingly close this report with a recommendation to that effect.

NEW YORK, *March 4, 1890.*

A classified table showing the total number of art exhibits from all countries and comprised in Group I.

Countries.	Class I.— Oil paint- ings.	Class II.— Different kinds of paintings and draw- ings (water colors, pas- tels, black and white).	Class III.— Sculpture and en- graving on medals.	Class IV.— Drawings and models in archi- tecture.	Class V.— Engravings and lithog- raphy.	Total number of exhibits of each country.
France.....	1,418	213	561	138	444	2,774
Algeria	55	10	9	11	.....	65
Colonies	1	2	4	.....	.....	7
Germany	64	24	4	.....	.....	92
Austria-Hungary	124	15	18	..	2	159
Belgium ...	252	34	53	38	71	448
Denmark	190	9	17	7	3	226
Spain	116	40	8	1	15	180
United States	336	117	16	1	102	572
Finland	56	2	17	.....	2	77
Great Britain	172	176	39	93	72	552
Greece	46	10	25	6	4	91
Italy	188	33	98	5	3	327
Norway ...	125	6	10	..	2	143
Netherlands	174	43	2	31	38	288
Roumania	135	4	16	4	.....	59
Russia . .	146	24	32	.....	3	205
Servia	20	.....	6	.....	.....	26
Sweden	150	42	30	2	4	228
Switzerland.....	92	21	19	16	20	168
International	49	8	5	.....	.....	62
Luxembourg.....	.....	.....	3	.....	.....	3
Principality of Monaco	6	1	4	1	.....	12
Republic of St. Marin .....	.....	1	1	1	.....	3
Hawaii.....	1	.....	.....	.....	1	2
Argentine Republic.....	.....	.....	3	1	3	7
Bolivia	4	2	.....	2	.....	8
Chili	25	.....	7	.....	.....	32
Ecuador .....	.....	1	3	.....	.....	2
Guatemala	17	2	3	.....	2	24
Salvador	19	1	2	4	.....	26
Uruguay	11	3	.....	.....	.....	14
Mexico.....	25	.....	3	.....	.....	28
France, Centennial Retro- spective.....	3,897	844	1,018	362	791	6,912
Water colors.....	652	634	269	376	465	2,396
Pastels.....	.....	463	.....	.....	.....	463
.....	.....	153	.....	.....	.....	153
Designs, various, from state manufactories and provin- cial schools, estimated.....	.....	.....	.....	.....	.....	2,000
Total.....	4,549	2,094	1,287	738	1,256	11,924

JURIES.

CLASSES I AND II.

OIL PAINTINGS, DIFFERENT KINDS OF PAINTINGS AND DRAWINGS.

OFFICERS.

Meissonier, J. L. Ernest, *President*, France.
 Artz, D. A. Constant, *Vice President*, Netherlands.
 Lafenestre, Georges, *Rapporteur*, France.
 Dannat, William T., *Secretary*, United States.

MEMBERS.

Bonnat, Léon.....	France.	Portaels, Jean.....	Belgium.
Bouguereau, A. William.....	do...	Robie, Jean.....	do...
Breton, A. Jules.....	do...	Verlat, Charles.....	do...
Carolus-Duran, E. A.....	do...	Tuxen, L.....	Denmark.
Cazin, J. Charles.....	do...	Mélida, Enrique.....	Spain.
Duez, Ernest A.....	do...	Hawkins, General R. C....	United States.
Fantin-Latour, Henry J. T.....	do...	Pearce, Charles S.....	do...
Fourcaud, Louis de.....	do...	Armitage, Edward.....	Great Britain.
Français, F. Louis.....	do...	Davis, H. W. B.....	do...
Gérôme, Jean Léon.	do...	Ouless, W. W.....	do...
Gervex, Henri.....	do...	Besnard, Albert	Greece.
Henner, Jean Jacques.....	do...	Pittara, Charles.....	Italy.
Laurens, Jean Paul.....	do...	Becker, A. de.....	Finland.
Mantz, Paul.....	do...	Skredsvig, Christian.....	Norway.
Puvis de Chavannes, Pierre.....	do ..	Willy-Martens	Netherlands.
Roll, Alfred P....	do...	Pranishnikoff, Ivan ..	Russia.
Vollon, Antoine.....	do...	Salmson, Hugo.....	Sweden.
Jettel, Eugène de.....	Austria-Hungary.	Meuron, A. de.....	Switzerland.

International section.

Heilbuth, Ferdinand..... | Kuehl, Gotthardt.....

SUPPLEMENTARY JURY.

Michel, André.....	France.	Thoren, Otto de.....	Austria-Hungary.
Busson, Charles.....	do...	Robert, Alexandre.....	Belgium.
Galland, O	do...	Frolich, Lorenz.....	Denmark.
Gosselin, Charles	do...	Beruete, A. de ...	Spain.
Hamel, Maurice.....	do...	Bartlett, Paul W.....	United States.
Harpignies, Henri.....	do...	Rossi, Luigi.....	Italy.
Lerolle, Henri.....	do...	Thaulow, Fritz.....	Norway.
Deschamps, Charles W....	Great Britain.	Hagborg, Auguste.....	Sweden.

International Section.

Roger-Ballu.

CLASS III.

SCULPTURE AND ENGRAVINGS ON MEDALS.

OFFICERS.

Guillaume, Cl. J. B. Eugène, *President*, France.
 Groot, Guillaume de, *Vice President*, Belgium,
 Kaempfen, Albert, *Rapporteur*, France.
 Gille, P. H., France, *Secretary*, France.

MEMBERS.

Cavelier, Pierre Jules.....France.	Saglio, Edmond.....France.
Chaplain, Jules Clément.....do...	Beer, Frederick de ...Austria-Hungary.
Chapu, Henri M. A.....do...	Thornycroft, Hamo.....Great Britain.
Dubois, Paul.....do...	Rossano, J.....Italy.
Falguière, Alexandre.....do...	Romanelli, R.....do...
Frémiet, Emmanuel.....do...	Hasselberg, Pierre.....Sweden.
Lefevvre, Albert.....do...	Rohmann, Robert.....Russia.
Rodin, Auguste.....do...	Bisbing, Henry S.....United States.

SUPPLEMENTARY JURY.

Courajod, Louis.....France. | Marquiset, L. H.....France.

CLASS IV.

DRAWINGS AND MODELS IN ARCHITECTURE.

OFFICERS.

Bailly, Antoine Nicholas, *President*, France.
 Waterhouse, J. W., *Vice President*, Great Britain.
 Baudot, de, *Rapporteur*, France.
 Pascal, J. Louis, *Secretary*, France.

MEMBERS.

André, Jules.....France.	Lisch, Juste.....France.
Boeswillwald, Emile.....do...	Vaudremer, Joseph A. E.....do ..
Garnier, J. L. Charles.....do...	White, W. P.....Great Britain.

SUPPLEMENTARY JURY.

Magne, LucienFrance. | Pauli, A.....Belgium.
 Moyaux, Const.....do... |

CLASS V.

ENGRAVINGS AND LITHOGRAPHY.

OFFICERS.

Delaborde, le Vicomte, *President*, France.
 Biot, Gustave, *Vice President*, Belgium.
 Bracquemond, Felix, *Rapporteur*, France.
 Stewart, Julius L., *Secretary*, United States.

MEMBERS.

Blanchard, Emile, O.....France.	Waltner, Charles A.....France.
Flameng, Léopold.....do...	

SUPPLEMENTARY JURY.

Béraldi, M, France.

Table alphabetically arranged, giving the number of awards allotted to the different countries at the Paris Exhibition, 1889.

Countries.	Medals of honor.					First-class medals (gold).					Second-class medals (silver).					Third-class medals (bronze).					Honorable mentions.					Total.
	Class I.	Class II.	Class III.	Class IV.	Class V.	Class I.	Class II.	Class III.	Class IV.	Class V.	Class I.	Class II.	Class III.	Class IV.	Class V.	Class I.	Class II.	Class III.	Class IV.	Class V.	Class I.	Class II.	Class III.	Class IV.	Class V.	
Algeria	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
Austria-Hungary	1	...	...	...	...	3	...	...	...	...	3	...	...	...	...	10	3	1	...	...	12	...	2	...	...	35
Argentine Republic	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bolivia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Belgium	3	...	4	1	...	6	...	3	1	1	9	...	4	2	2	25	1	5	...	1	8	1	2	2	3	84
Brazil	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	2
Chili	...	...	...	...	...	...	...	1	...	...	1	...	1	...	...	1	...	...	...	2	...	1	...	...	...	7
Denmark	1	...	...	...	...	3	1	1	1	...	6	...	1	...	...	10	...	3	...	...	21	3	...	...	...	51
Ecuador	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Finland	1	...	...	...	...	...	...	1	...	...	5	...	...	...	...	6	...	1	...	...	4	1	...	...	...	19
France	13	...	9	10	5	59	4	42	24	14	91	7	49	23	13	186	19	81	36	17	130	11	38	17	13	911
Germany	2	...	...	...	1	1	...	...	...	...	3	2	1	...	...	9	1	...	...	...	7	1	1	...	...	29
Great Britain	2	...	2	2	1	10	7	...	2	2	12	12	1	5	2	28	15	5	5	1	11	2	2	...	...	129
Greece	...	...	...	...	...	...	...	...	...	...	1	...	...	2	...	6	...	2	1	...	...	...	2	...	...	14
Guatemala	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1
Hawaiian Islands	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Italy	1	...	3	...	...	6	2	3	...	...	6	3	4	...	...	24	...	8	1	...	21	4	29	...	...	115
International section	...	...	...	...	...	2	...	...	...	...	3	...	...	...	...	6	1	1	...	...	...	...	...	...	...	13
Luxembourg	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1
Mexico	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	2	...	1	...	...	1	...	...	3	...	9
Norway	1	...	1	...	...	2	...	...	...	...	8	...	...	...	...	7	...	...	...	...	14	1	2	...	...	36
Netherlands	1	...	...	...	...	2	1	1	...	...	11	3	...	1	...	16	1	1	1	2	17	...	...	1	2	61
Principality of Monaco	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	2
Republic of St. Marin	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
Russia	1	...	1	...	...	4	1	...	...	...	6	2	2	...	...	15	1	...	...	...	8	1	3	...	...	46
Roumania	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	1	...	2	2	...	6	...	1	2	...	16

Spain	1	...	...	...	...	...	...	8	1	1	1	1	1	14	3	2	...	...	11	3	...	...	...	51
Servia	...	...	...	...	...	...	...	1	...	...	...	...	...	1	...	2	...	...	1	...	...	...	...	5
Sweden	1	...	...	...	...	...	...	6	1	1	1	1	1	9	...	2	...	1	12	2	3	...	...	44
Switzerland	...	...	...	...	...	...	...	3	2	...	1	...	...	15	3	2	...	...	12	2	3	...	...	48
Salvador	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
United States	2	...	1	...	...	...	...	1	14	6	...	...	2	38	2	1	...	2	24	4	4	...	3	110
Uruguay	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	2	...	...	...	...	3
Total	31	..	21	13	7	110	21	200	39	66	39	21	21	431	50	120	47	24	324	32	101	26	21	1,846

RECAPITULATION.

Numbers of medals of honor including the five classes	72
Number of first-class medals (gold), including the five classes	233
Number of second-class medals (silver), including the five classes	365
Number of third-class medals (bronze), including the five classes	672
Number of honorable mentions, including the five classes	504

[Journal des Débats, September 22, '889.]

The painters of the United States travel a great deal; they are very well informed as to what happens abroad, and they don't disdain on occasion to profit by their knowledge. We find in their Exhibition, very interesting by the way, more than one reminder of Jules Dupré, Théodore Rousseau, Cazin, Millet, Jules Breton, and of Whistler—who is, by the way, American by birth and English by adoption—of Puvis de Chavannes, of the Japanese artists, of Mr. Gérôme, and even of Mr. Bouguereau, whose conceptions are repeated in Miss Elizabeth Gardner. There is, however, one trait which distinguishes them; it is a certain incisive and cold manner, phlegmatic and, as it were, indifferent. What they do undoubtedly interests them, since they do it; what they paint pleases them; but they seem to bring to it, for the most part, a rare power of objectivity. *Nil admirari* is their motto; don't try to astonish them, don't try either to surprise them, *flagrante delicto*, in a fit of enthusiasm; they don't yield to it, and they will detect the attempt.

Mr. J. Gari Melchers, a pupil of Messrs. Lefèvre and Boulanger, has chosen his residence in the Frisian cantons of Holland. The marked types of the peasants, their dress, their manners interest him. It is impossible to put more precision, penetration, strength, and frigidity, I do not say impersonality, into a *procès-verbal*, than he has put into his remarkable studies, "The Pilots," "The Sermon," and "Communion." We have known these pictures already from having seen them in former Salons; no one will regret seeing them again.

Mr. William Dannat, who calls himself a pupil of Munkacsy on the catalogue, made his début in the atelier of Carolus Duran; he seems to-day to incline towards Whistler. "A Quartette" and "A Sacristy in Aragon" are in his first manner, less self-contained, less subtle; but we admire in them at once a rare delicacy of eye, and his individuality is clearly written. The profile of the blonde in "A Study in Red," portrait of a woman in white, tone upon tone, reveals aspirations more and more refined, a great sureness of hand, and the most delicious talent.

The "View at Venice," of Mr. Ralph Curtis, all in tender rose, fine violet, light amber, and subtle lilac colors; "Evening by the Lake," of W. S. Allen, pupil of Messrs. Bouguereau, J. Lefèvre, and Claude Monot; "A City Park," "Stoneyard," and "A Bit of Long Island," of Mr. William Chase (who exhibits also some very good portraits), and a "Peace," all in white on a charming silver-blue ground, are of exquisite expression.

One is much surprised to find alongside of these clear, luminous, and distinctly modern pictures landscapes which appear to have been painted thirty or forty years ago, like those of Messrs. Gifford, Minor, Henry, etc., inspired no doubt by the Jules Duprés and Diazs imported into America.

There is much charm, a charm a little sad, in "A Winter Eve," "The Valley (evening)," and "Evening after the Storm," of Mr. Charles Davis, as also in "The Shepherdess," "Evening," and "Melancholy," of Mr. Charles Sprague Pearce (a pupil of Bonnat). "The Wave," of Mr. Alexander Harrison (a pupil of Gérôme and of Bastien Lepage), would be a pure *chef-d'œuvre* if the foreground were not a little hard. It is impossible to paint with a more delicate sentiment and a finer tone the tremulous light which on a clear morning shimmers with a tender and changing rose the milky-green of the sleeping sea.

Mr. John Sargent was born at Florence of American parents; he is a pupil of Mr. Carolus Duran, and, like Whistler, is established in London, where his talent for portrait painting is highly appreciated. He is a nervous painter, and consequently unequal. We had already seen the charming portrait of children which he exhibits, but that of "Mrs. W." in white satin, pearl necklace, a fan in her hand, standing on a ground of amber grey and pale gold, is of a fine and spirited elegance.

What is a little wanting in this American Exhibition is native painting on native subjects. We doubtless find it here and there in Messrs. Ulrich, Inness, Whit-

tredge, and Simmons, for example, but it is not marked. Messrs. Mosler, Knight, Vail, Delachaux, Stewart, Bridgman, Weeks, Mac-Ewen, Boggs, Bisbing, Butler, Walker, Gay, Thayer, and Hitchcock (pupils of Messrs. Boulanger, Lefèvre, Bouguereau, Bonnat, Gervex, Roll, Dagnan-Bouverat, Hébert, J. P. Laurens, Gérôme, Colin, etc.) go to Holland, to Brittany, to Normandy, to Touraine, to the banks of the Oise, or even remain in Paris. They are, however, for the most part, good recruits for the young American school and everything tells us that we must take it more and more into serious consideration.

ANDRÉ MICHEL.

SECOND GROUP.

EDUCATION AND LIBERAL ARTS.

(EXTRACT FROM THE OFFICIAL CLASSIFICATION.)

SECOND GROUP.

EDUCATION AND LIBERAL ARTS.

- CLASS 6. Education of young children; primary instruction; instruction of adults.
- CLASS 7. Organization and appliances for secondary instruction.
- CLASS 8. Organization, methods, and appliances for higher instruction.
- CLASS 9. Printing and books.
- CLASS 10. Stationery, bookbinding, and articles used in painting and drawing.
- CLASS 11. Ordinary application of the arts of drawing and modeling.
- CLASS 12. Photographic proofs and apparatus.
- CLASS 13. Musical instruments.
- CLASS 14. Medicine and surgery; veterinary and comparative medicine.
- CLASS 15. Instruments of precision.
- CLASS 16. Geographical and cosmographical maps and apparatus; topography.

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EDUCATION AND LIBERAL ARTS.

By ARTHUR J. STACE, Commissioner.

[Classes 6 to 16, inclusive, except Classes 12 and 15, reported by other persons.]

Before treating at length the subjects embraced by each class of the Second Group it may be well to state under what conditions the results of education can be exhibited in the showcases of a public library. True education, let it be understood, in the first place, is for use, not for show. The less the show-off principle prevails in educational establishments the more thorough will be the work done, generally speaking. Of course there are classes of educational work, drawing, for instance, necessarily intended for display; but these are mere accessories to the true work. The brains and hearts, the minds and manners, of the pupils can not be labeled and placed on a shelf for general inspection.

Again, we must consider that public expositions are made chiefly for advertising purposes. However glibly we may talk of national honor, national pride, etc., the hard fact confronts us continually that the love of personal gain prevails here over every other motive. Now, institutions of world-wide or even national celebrity do not need to advertise themselves, and if they appear at all in an exposition of this kind it is entirely from motives higher than the desire to make money. It is true that such educational establishments as are still young and struggling for recognition will be apt to use this means of obtaining it; and their elder sisters may disdain to enter into seeming competition with them. Hence, while duly grateful to those among our better known universities that have recognized the duty of doing what they can for national honor, we must not feel surprised that others have taken a view of the subject that has placed this duty in a different light.

Other circumstances have kept whole classes of educational workers out of this competition. No one can walk the streets of Paris without occasionally meeting the orderly ranks of schools under religious direction. Now, these schools, numerous as they are in Paris and throughout France, are not represented at the Exposition. This is in consequence of the measure known as the *laïcisation* of educa-

tion adopted by the French Government. The measure is intended to secure what is called "nonsectarian" education. It should be understood, however, that the strife in France is not between different forms of Christianity, but between Christianity itself and infidelity. In the United States we may be *theoretically* in favor of the *laïcisation* of education, but what we think of it *practically* may be inferred from the fact that, as a rule, the presiding officer of our higher institutions of learning prefixes the title "Rev." to his name. We are, in fact, in favor of nonsectarian education for *other people's children*, but when the guidance of those near and dear to us is in question we prefer to intrust it to the care of those who profess Christian principles.

There will probably always be a large class in France who will share this sentiment with us and who will feel that their offspring are safest under religious guidance, let the Government discourage this feeling as it may.

It is also to be remarked that the plausible maxim, "Teach the child nothing but what you know positively to be true," is to blame for the chief faults observable in the modern schemes of education. The error is that this maxim measures the importance of knowledge by the certainty with which it can be grasped. We may be absolutely certain of all that can be known about a regular dodecahedron—of the equality of its faces, edges, and solid angles, and of the method by which its solid contents may be calculated. But what of it? What has the dodecahedron done to increase the sum total of human happiness? The so-called facts of history are by no means certainties, and yet an acquaintance with them is of far more importance in education than a knowledge of the properties of the dodecahedron. Few, if any, sciences are more essential to our bodily well-being than that of medicine, and yet medicine may be described as a tissue of uncertainties, for symptoms vary in different cases, and, even when a remedy is ascertained to be efficacious against a given disorder in general, particular cases will always arise in which it will be found to be fallacious. We should not lose sight then of this fundamental error in the "matter-of-fact" or "Gradgrind" system of education, and in estimating the value of its results we must consider them as attained in spite of, rather than in accordance with, its ruling principle.

To illustrate the error of this matter-of-fact principle, let us consider it in one of its prominent phases—the theory that, since the forms with which elementary geometry deals are the simplest, they must be the first to be learned. Some years ago there was a fancy for taking "combined" photographs, where several faces were photographed one upon the other, and the result, instead of a mere blur, showed well-defined human features. How very slight, then, must be the geometrical measurements by which one human face differs

from another, and yet the infant, long before it can speak or even understand what is said to it, will recognize its mother's face and distinguish it from all others. But the modern educator says: "No; it must first learn how to distinguish a pyramid from a parallelopipedon. The human face is a very complex object and should be among the last to be studied." True, my dear sir, but you forget that the ideas of simplicity and complexity belong to the logical faculty, and that this faculty is among the last, instead of the first, to awaken in the soul. In some people it never awakens at all, while the affections and sympathies are thoroughly developed and render the individual a valuable member of society. The childish fictions of Cinderella and the Sleeping Beauty, which the matter-of-fact system banishes, contain more vital truths than a whole boxful of kindergarten models. With these few remarks premised, the writer will enter upon a detailed report of what is to be found in the buildings of the Exposition.

CLASS 6—EDUCATION OF YOUNG CHILDREN—PRIMARY INSTRUCTION—INSTRUCTION OF ADULTS.

The lowest form of education is that supposed to be given in the *crèche*, or asylum in which infants in arms are left by mothers whose life of toil obliges this temporary desertion. None but those countries in which the struggle for existence is very severe have introduced the *crèche* system. No models of it are presented at the present Exposition. Japan exhibits toys which are said to be designed for the use of *crèches*; but, as they do not differ essentially from toys to be used in the domestic nursery, they may be referred to Class 40, which deals with toys in general.

FRANCE.

Of the *Écoles Maternelles*, or kindergartens, and the successive grades of primary schools, France makes a very complete exhibit, both as to models, methods, apparatus, and pupil-work. Beginning at the lowest grades, we find ingeniously devised alphabets in attractive colors, frames of wire and beads to teach numeration and decimal notation, followed by the fundamental rules of arithmetic, geometrical solids in wood, that the child may combine into various structures, paper cutting and folding, that simple art to which the high-sounding name of "papyroplastics" is sometimes given. All this is excellent of its kind, and not too expensive to risk in the hands of young children. Pupil work is not wanting, even at this early stage. Pencil sketches in outline are shown, which the tender years of the pupil, marked upon them, alone render interesting. Outlines of simple, well-known objects—men, birds, beasts, fishes, fruits, and flowers—are supplied as copies. So far every thing is

found that we should expect in the familiar kindergarten. It is to be regretted that the seats provided for the little ones are constructed on the mistaken principle that the body should be bent at right angles when in the sitting posture. There is no support for the back except a single bar, placed at about the height of the shoulders. It is true these seats are cheap at first cost, but if they produce spinal disease they will be found eventually dear at any price.

As the grades advance, the mysteries of French syllabication are taught by large charts, which can be read by a whole class of little ones at the same time. Here, those whose knowledge of French has proved sufficient for the practical purposes of reading and speaking may be surprised to find that "silent" *e*, as it is called, is efficient in forming French syllables—"Fran-ce," for instance, being a dissyllable, not a monosyllable, as with us. It is an excellent thing to find syllabication reduced to a formal system, not dependent, as among us, on the varying customs of printers. The Arabic as well as the Roman numerals are now taught, both as printed and written. Writing is introduced as a study soon after the first lessons in reading and pupil work in the form of written exercises and numerical calculations is liberally exhibited at this stage of educational progress.

The child is now very properly taught to reverence the illustrious characters of history, whose lives and deeds are narrated to interest and instruct him. In a series of twelve subjects we find: "Charlemagne, St. Louis, Du Guesclin, Gutenberg, Joan of Arc, Christopher Columbus, Bernard Palissy, Saint Vincent of Paul, John Bart, Fénelon, The Abbé de l'Epée and Parmentier"—a sufficient variety, calculated so that each may make a distinct impression on the youthful mind.

We are glad to notice that plain and fancy needlework is at this time taught to girls, affording some very creditable exhibits of pupil work. Boys of the rural districts are now supposed to learn agriculture, but we all understand what the result of farming, as taught in the schoolroom, must be.

The culture of the voice is begun at an early age and continues throughout the course. The principles of musical notation are taught in class from large charts. Instrumental music is, of course, an "extra."

The boys practice drilling and military evolutions not only with a view to possible future active service but as a means of physical culture. Gymnastic and calisthenic exercises of many kinds aid in the development of strength and suppleness in both sexes.

Drawing is continued and its results become more and more satisfactory. Coloring is begun. Objects "in the round" are presented as models. Natural productions are used when it is possible to preserve shape and color in the dried state—as is the case with wheat

and other grains. Skillful imitations of such flowers and fruits as would fade or wilt in drying are given. A series of ten objects for copying consists of the grapevine, flax, potato blossom (white), nightshade, tobacco, foxglove, saffron, wheat, barley, and rye. The last three were natural; the others, particularly the foxglove, excellent imitations. The young man in charge of this exhibit seemed unaware that potato blossoms were ever of any color other than white. That is the misfortune of all plans of teaching—they only convey partial views on any subject.

Now follow studies in French grammar, geography, history, and mathematics. French orthography and grammar are probably easier to the French child than English grammar and orthography to the English or American. But even French orthography has its difficulties. A fool (*sot*), a seal (*sceau*), and a slop-bucket (*seau*) differ only in the spelling, and we suspect that French genders are learned by practice rather than by book. Geography is taught by the usual wall maps, both blank and lettered. French history naturally is the first presented. Then follow the histories of Rome and Greece, of the Middle Ages and modern times. Mathematics embraces several branches which are not usually regarded as belonging to a primary course. Arithmetic, very much simplified of course by the use of the metric system, geometry and even trigonometry, as far at least, as it concerns the use of drawing instruments, belong here. Perspective is also taught and the various projections used in drawing.

Literature is brought under the child's notice at an early age, in the course of reading prepared for him, both in poetry and prose. Among the books designed for use in the primary schools we find Boileau's "*L'art poétique*," Bossuet's Sermons on the Word of God and on Death, Buffon's treatise on Style, Chateaubriand's "*Martyrs*," select poetry by several editors, two of Corneille's dramas, Fénelon's "*Opuscules académique*," La Fontaine's "*Fables*," Selections from Lamartine, Michelet's "*Jeanne d'Arc*," Molière's "*Misanthrope*," Rousseau's "*Emile*," Madame de Sévigné's letters, and selections from Voltaire. These are evidently designed to form the pupils' style, and upon these models he is exercised in the art of composition.

A course of modern languages, English and German at least, is begun in the primary schools. Latin has not yet been taught, but Latin would hardly help the French child to learn either English or German, as the English words derived from Latin chiefly come through the French. Book-keeping and business correspondence, both French and foreign, also come in here, and supply instant practice in the modern languages. We must take exceptions to some "*Rules for address in English*" which we found among the book-keeping exhibits, where the form "*Sirs*" is directed to be used in

addressing the gentlemen of a firm. If such a form be in actual use, either in England or America, it has escaped the writer's notice.

The moral and civic instructions which the pupil now receives seem chiefly to relate to patriotism and the military virtues. The Life of Christ, and Bible History, however, are to be found in the prescribed course, and religious instruction, where the parents of the child desire it, is imparted to some extent, although it can hardly be said to form a prominent feature.

Many exhibits have been made by the private enterprise of dealers in school books, apparatus, and furniture. Of these it may be said in general that they are in the first place cheap, and secondly, that with the exception of the benches already mentioned, they are good enough for the purposes for which they are designed. The French are economical people, and it is quite right that the means of education should be placed within the reach of the most indigent.

The work of a Lyons municipal school deserves special mention for the beautiful decorative designs woven in silk, which constitute a peculiar industry in that city.

Duployé's method of stenography, with newspapers, books, and maps printed in the stenographic characters, is particularly interesting.

The houses of education of the Legion of Honor, under the care of General Rousseau, should be specially mentioned for the creditable character of pupil work displayed, consisting of the written exercises for the various branches of instruction, finely executed drawings, and some excellent needlework.

BELGIUM.

In the Belgian catalogue we find a complete and statistical report of the common-school system in that country, and of all systems represented in this Exposition it seems to have succeeded best in the general diffusion of knowledge, reaching a larger percentage of the population than any other, Germany not being here. The school laws are liberal, and funds abundant. Superannuated and infirm teachers are pensioned off, and the widows and orphans of teachers are also supported by public money. Poor children receive gratuitous instruction. The teacher is forbidden to make the more intelligent pupils the object of his special care, to the neglect of others, a rule so difficult to be observed that we imagine it must frequently place the teacher at the mercy of jealous parents, who will accuse him of having infringed it, if any pupil should appear to more advantage than their own goslings. The children of the poor are supplied by the commune with books and slates and other necessary school equipments. Teachers may not accept of gifts from their pupils. Visits are to be made by physicians to report on the sanitary condition of the schools, and these are to be constant in times

of epidemic. Children afflicted with contagious disorders are sent home, not to return without a certificate of cure from the physician. No corporal punishment is to be inflicted, nor any of such a nature as to discourage the children or to expose them to the ridicule or contempt of their companions. If this rule is strictly followed it is equivalent to the prohibition of punishment altogether. Even the withholding of rewards discourages children and exposes them to ridicule and contempt. The teacher must have a pretty hard time of it, and richly earns the pension provided for his declining years. The rewards are good points, monthly certificates, a position on the list of honor, and the premium given at the end of the scholastic year. A garden is attached to each school, and the teacher is to keep it so as to convey practical notions of agriculture, horticulture, and arboriculture. It is to be a model garden, containing the finest varieties of vegetables and fruit trees. Let us hope that the season for green apples falls in vacation. The teacher also buys the necessaries for class use that his pupils require. Private schools, under certain conditions, may be adopted into the public system.

Boys devote 8 hours a week to reading, 2 to writing, 4 to arithmetic, 2 to drawing, and 1 each to geography, history, singing, gymnastics, and agriculture, 21 in all. Girls spend one hour less in reading, arithmetic, and drawing, and omit the agriculture, that they may give 4 hours to needlework. Where religion and morality are taught, 3 hours a week are devoted to them, and these instructions must be given either at the beginning or close of school, that those whose parents wish it may not be obliged to attend. Domestic economy and housework, although not obligatory, are nevertheless taught in the girls' school of the higher primary grade, according to a system authorized by law. Whether taught at specified hours or not, the instructress is expected to make useful remarks on these subjects in connection with the studies in reading and arithmetic, as occasions offer, and to accustom the children to habits of order and cleanliness, as well as to familiarize them with the spirit of foresight. Special *écoles ménagères* have been established in the principal centers of industry in Belgium, where domestic economy is the prominent feature. There are many obstacles to prevent housework and cooking from forming an essential part of the course of common-school education, such as the necessity of general education, the diversity of branches already on the programme, the youth of the pupils, the few years allowed to pupilage, the irregularities of attendance, the insufficient preparation of teachers, the thronged schoolroom, and the necessary additional expense.

Less inconvenience seems to attend the introduction of manual labor as a feature in the boys' schools, with which the government of Belgium is now occupied. The aim is not so much to prepare for any particular trade as to cultivate manual skill in general and to

exercise the faculties of attention, perception, and intuition. The first practical measures to this end were taken in 1887, a temporary normal course having been organized at Nivelles, to initiate a certain number of professors and teachers into the mysteries of manual labor. Fifty persons, teachers chosen from among the more capable, were admitted to follow this course, which lasted a month, and which consisted of *practical work* and *lessons*, as follows:

- (1) A choice of occupations borrowed from Froebel's method.
- (2) Pasteboard work, or papyroplastics; preparation of fifty graded models.
- (3) Woodwork, after the method of Otto Salomon, adapted to the wants of Belgian schools; preparation of fifty graded models; acquaintance with tools and their management, with the care to be taken of them; principal kinds of wood, their value and use.
- (4) Conferences on the following matters:
 - A. Concerning the teaching of manual labor as a branch of general education. Its objects and advantages from an educational point of view.
 - B. Organization of manual labor instruction in the primary school; preparation of the teacher; the workshop, apparatus, etc.; the expense; the age at which children ought to begin manual work; number of pupils to be admitted to the workshop; choice of occupations, programme and models; time to be devoted to this pursuit; methods.
 - C. Review of the history of teaching manual labor to boys.
- (5) Didactic exercises, followed by discussions as to the methods and course pursued.

This course of training occupies 170 hours, of which 95 go to woodwork, 50 to papyroplastics, 15 to Froebel, and 10 to the conferences.

The experiment at Nivelles having proved satisfactory, instruction in manual labor has been definitely introduced in all the normal schools of the kingdom.

The establishment of schools for adults, with teaching after work hours and on Sundays, is encouraged by the Government. Such schools, however, can not, for obvious reasons, be regulated by law. The matters taught are as follows: The vernacular, the elements of arithmetic and the metric system, drawing, geography, the history of Belgium, constitutional law, and hygiene. Agriculture, modern languages, and natural sciences are extra. Certificates of capacity are awarded for proficiency in these branches.

The system pursued in normal schools seems to be very nearly perfect—in theory, at any rate. The director and instructors are to neglect no occasion of inspiring their pupils with love and respect for national institutions and for public liberty. They are to abstain, in their instructions, from any attack on religious belief. The di-

rector will take measures to secure for each pupil complete liberty to fulfill the religious duties prescribed by the church to which he belongs.

The course of instruction embraces, as necessary branches :

(1.) The precepts of morality. (2) Elementary notions concerning the constitution and government of the country and the laws concerning primary schools. (3.) The theory and practice of teaching. (4.) The vernacular, reading, grammar, and orthography, explanation of authors, exercises in composition and elocution. (5.) A second language (French, Flemish, or German), according to the needs of the locality. (6.) Arithmetic in theory and practice and a complete explanation of the legal system of weights and measures. (7.) Geography, and particularly the geography of Belgium. (8.) The principal facts of general history and the details of the history of Belgium. (9) Elements of agriculture in the school for male teachers and needlework in the female department. (10.) Writing. (11.) Drawing. (12.) Vocal music. (13.) Gymnastics.

In addition to these obligatory studies, male teachers may take a course in algebra, as far as equations of the first degree; in geometrical forms and the demonstrations of plane geometry, and the practice of surveying; in elementary natural science, natural history, physics, and chemistry; in hygiene; in bookkeeping, and in manual training. Female teachers may also study the geometrical forms, elements of natural science, natural history and physics, hygiene, bookkeeping, domestic economy, housekeeping, and gardening. A third language (German, Flemish, or English, according to the locality) may also be studied by teachers of either sex.

Very creditable statistics are given, showing the present state of education in Belgium, both in the normal and primary schools.

A National School Museum was founded in 1882, having for its principal object to show from every point of view the existing state of primary and normal education in Belgium, exhibiting the buildings, furniture, health of the pupils, organization, books, methods, apparatus and collections, work done by the pupils, kindergarten, schools for adults, schools for housekeeping, statistics, etc. It is open to the public from 10 o'clock in the morning until 4 in the afternoon. Collections of minerals, vegetables, and animals may be added, with specimens of woodwork.

Special exhibits worthy of notice are the atlases and maps of Professor Du Fief, intended both for the primary and the secondary schools. The connection between geography and history has been evidently an object of thought, and the professor's merits have been acknowledged by medals awarded at our Centennial in 1876 and other Expositions.

Mr. Flesch, a teacher at Fayt-lez-Seneffe exhibits forty-five albums

of work done by pupils in the three degrees of the primary schools during the scholastic year of 1887-'88.

Mr. Hubert furnishes plans, drawn by himself, of the State Normal School at Mons, according to his own designs.

The Deaf-Mute Institution at Perchem-Sainte-Agathe send a very interesting report on the history and present condition of their house, with works on physiology, domestic economy, etc.

The well-known architects, Messrs. Seghers, exhibit plans and elevations of the *crèche* asylum built at Willebroeck.

Professor Van Sweevelt, whose specialty is manual training, furnishes a methodical series of drawings of common things, adopted for teaching modeling in wood in the Belgian schools; also, collections of wood models and a practical treatise on modeling as conducted in the schools.

Professor Watelle exhibits his singing course and method of instruction as carried out in Belgian schools, both primary and normal, with his theory and practice of vocal music.

Professor Snyckers displays his books for the use of the deaf who are able to speak.

Professor Lebon has some very full researches into the present state of education in Belgium, comprising the history of popular instruction, with copious statistics and notes.

Mr. Adrian has a scheme for the measurement of areas, and a collection of solids capable of development on a plane surface.

UNITED STATES OF AMERICA.

Reports from the boards of education of several cities and from the departments of public instruction in several States have been forwarded to this Exposition. The Boston public schools have attracted much attention by their fine display of text-books, reference-books, drawings, casts, furniture, and students' work. Whether the "Cooper Union" is correctly classed here in our catalogue must be open to discussion. Twelve fine oil paintings and three portfolios of drawings in colors, as well as crayon, seem to place this institution far above the level of primary instruction. The Convent of the Good Shepherd, Newport, Kentucky, sends some fine specimens of calligraphy and fancy work. The public school of Elizabeth, New Jersey, sends a portfolio containing a map of the city, course of study, and students' work, very well executed and interesting. The Christiansen Institute of Brooklyn exhibits kindergarten work in bright colors and tasteful forms, showing that the little ones are at least kept out of harm's way. The Institute of Our Lady of the Sacred Heart, Washington Heights, Illinois, affords some beautiful specimens of pupil work in the form of maps, neat handwriting and drawing. The Marianna Institute, of Marianna, Arkansas, has also sent some elegant scholars' work. The Moline Public Schools of Illi-

nois are conspicuous for their clay models. They have six frames of geographical clay modeling, six clay panel models, and three boxes of plain clay models. Besides this they exhibit two portfolios of sewing, fourteen paper boxes, and twelve volumes of drawings. The Mystic Valley Institute, Mystic Bridge, Connecticut, and Penn School, St. Helena Island, South Carolina, also send some very satisfactory scholars' work. Rowland Hall School, Salt Lake City, Utah, sends some fine work in drawing and botany. The brilliant coloring of the flowers in the Central Mountain region of North America renders these studies very attractive. A private school for young ladies, 429 Carondelet street, New Orleans, Louisiana, provides us with some excellent photographs showing school interiors and bright, happy cultured faces, with pupil-work, consisting of maps, charts, drawings, essays, and writing exercises. The Silver Street Kindergarten of San Francisco, California, shows students' work in drawing and writing. The Sockanosset School for Boys' Howard, Rhode Island, has a very interesting exhibit of manual work done by the boys. There are files of the Howard Times and specimens of job printing executed by the young compositors. The making of clothes and of brushes is also illustrated by specimen work. Photographs, both of the pupils and their home, with their exercise books and programme of studies, are added. The Superintendent of Education of Maryland sends articles of clothing made by normal school students, and scholars' work in drawing and botany. The State Public School of Coldwater, Michigan, and the Union School District of Concord, New Hampshire, also exhibit good specimens of scholars' work.

Small as is the number of private and public schools represented in these exhibits compared to the noble army of which it forms merely a scouting party as it were, it still shows that popular education in the United States is continually advancing in spite of the many disadvantages against which we have to struggle. The long distances which in our widely scattered settlements young children must walk, often through the storm, or breaking a fresh track through new fallen snow, to reach the solitary shelter of the schoolhouse would deter a European parent from permitting his little ones to attend at all. Not a year ago we read of the heroism of female teachers saving their infant charges amid the terrors of falling schoolhouses and blinding blizzards. Moreover, the United States in generously throwing open her ports to the needy and indigent of Europe, Asia, and Africa assimilates an uneducated element, and thereby lowers her own percentage of the educated to increase that of those countries whose surplus population she absorbs. In no other land are more generous sacrifices made in the cause of education. Nowhere else do children go so willingly to school; nowhere else do boys work hard the better part of a lifetime to secure them-

selves the benefits of education, even though its advantages are only to be tasted in old age.

It is gratifying to be able to add that the merits of the United States school system have been duly recognized by the juries appointed to make the awards, and that a large share of decorations bear testimony to the excellence of our educational houses.

SWITZERLAND.

In the public school system of Switzerland we find 544 infant schools, with 20,014 children attending them and 611 instructors. The number of primary schools is 7,180, with 467,597 pupils and 9,018 teachers. The normal schools have 1,638 pupils and 215 teachers. To appreciate these figures we must remember that the total population of Switzerland is 2,934,057.

Long before kindergartens were thought of, Swiss toys did their work for the young. Cheap, harmless, and amusing, with no dangerous sharp points or poisonous paint, they did a good work, which is still continued, though on principles more in accordance with modern views. Noah and his ark yield to prisms and octahedrons which the child *ought* to like far better.

The Swiss seats and school benches are perhaps a shade better than the French, but there is room for improvement still.

Gymnastic apparatus is very complete. As Alpine climbing requires both strength and activity, we should expect to find these qualities cultivated in Switzerland. Parallel bars, wooden horses upholstered with leather, clubs, and other appliances for development of muscle are shown.

Pupil work is abundantly displayed and is excellent according to the age of the children. The time of execution is marked upon the drawings and indicates that the pencil moves swiftly as well as surely.

MEXICO.

Our southern neighbor appears to be shaking off the torpor which her semitropical climate, her absorption of the indigenous races, and her numerous political convulsions, added to the ease with which the necessities of life are obtained, have superinduced.

The display of pupil work belonging to this class is very attractive. In particular we may notice the artificial flowers exhibited by a young ladies' school, in which taste in the selection of models and fidelity in the execution give evidence of industry among a class where it would be least expected.

BRAZIL.

Nowhere else, apparently, is the primary teacher advanced to so high a social rank and dignity as in Brazil, enjoying titles of nobil-

ity in other lands conferred rather on the sword than on the pen, and, if on the pen, only as it moves in the higher walks of literature. But in this Brazilian exhibit we see the noble and kindly figure of the Baron de Macahubas, surrounded by his happy young pupils, happy, indeed, in being committed to the charge of one whose gentle birth and breeding are evident in his demeanor. He has nature's patent of nobility stamped upon his brow, to which the social distinction conferred by his title is but a mere indorsement. Numerous photographs are furnished of the College Abilio, over which he presides. We see his pupils engaged in study and recreation, gymnastics and fencing. Drawing and exercise books are shown, giving evidence of their proficiency. Maps of several countries, Brazil, the British Isles, Portugal, Italy, and an entire map of Europe, executed by the pupils, are placed before us. The college itself is shown in plan, section, and elevation. The course of readers, a Portuguese grammar, and the works on the theory and practice of teaching by the Baron himself form another interesting part of the exhibit. An exercise-book exhibits the French verb compared with the Portuguese, showing that the French language forms a part of the course. In many of the copy-books we find poetical extracts, showing that the selection of reading matter is made under the dictates of a cultivated taste.

Other exhibitors are Ferreira, Rio de Janeiro, giving a useful treatise on housekeeping; the Commission of Rio de Janeiro, showing a movable alphabet for kindergartens, and a French grammar, being a translation of Lhomond. The Commission of Pernambuco also exhibits alphabets. Mme. Aubé and M. de Castro exhibit valuable treatises on educational subjects.

THE ARGENTINE REPUBLIC.

Education in this vast region is particularly interesting to us, as being modeled on the United States system. The exhibit in the primary class is somewhat meager, but it includes catalogues, photographs of schools and scholars with intelligent faces, together with a record of work done.

OTHER COUNTRIES.

Austria is principally represented by Messrs. Gorlach & Schenck, of Vienna, the medalists of several previous exhibitions, who show books on art, and artists' work. Fric, of Prague, Bohemia, has a display of objects in natural history for school instruction. Hungary presents us with a plan for a universal alphabet, one too many. The rage for a universal language is dying out. People are beginning to find out that languages *grow*; they cannot be made to order.

Chili has a beautiful exhibit of embroidery, flowers, boxes, and gloves from the professional school for young ladies at Santiago.

Denmark is following the general movement to introduce manual training into the primary schools. Sloejd Fsreningen exhibits material and models for this purpose. N. C. Rom also exhibits material for primary instruction.

From Egypt the normal school of Cairo has a very creditable showing of maps and drawing and exercise books, being the work of the pupils. The photographs of many intelligent faces among them also deserve notice.

Spain gives specimens of work from several of her educational establishments. The Academy of Fine Arts at Cadiz and the School of Arts and Trades in the same place, the Art School at Madrid, and the Institute at Barcelona all afford evidence of the successful training of eye and hand. Specimens of school books and the course of study are afforded by various business houses.

Greece furnishes the report of an orphan asylum at Athens. Guatemala exhibits school work from Baja-Verapaz, and also some furnished by the Minister of Public Instruction. Italy has a somewhat meager exhibit for a land in which education has never failed to reach a certain point, in spite of barbarian invasions. No school appears. The exhibitors are merchants who supply apparatus and furniture. Hawaii, on the contrary, proves that she has emerged from savagery, and makes a display of pupil work done in her State schools, which is remarkable, at least, for great originality.

Much that we see in the Japan exhibit seems to belong to this class. We find, however, that most of it has been catalogued as belonging to the next.

Luxembourg makes a grand-ducal exhibit of school furniture, pupil work, books, and statistics of her State primary schools, and a private exhibitor, Kemp, shows plans and specifications of school-houses erected in the grand duchy. In Norway Miss Marie Rosing makes a pretty display of work done in her girls' school at Christiania. In Holland we find an exhibit of school work performed in a normal school for young ladies destined to be kindergarten teachers.

Portugal and her colonies furnish an interesting, though small, display of pupil work from the College of the Regeneration and other institutions. The ethnography of Central Africa, with photographs of an expedition thither, and methods for speaking the languages of the country, furnished by Carvalho, of Lisbon, are particularly interesting, but seem to belong to a higher class than this of primary instruction.

Roumania is chiefly brought into this class by exhibits made by dealers in school apparatus, books, charts, maps, etc.

Even the Russian public schools seem to send no examples of students' work. Books and material constitute their supply. Finland, however, sends work done by sixteen primary schools and four normal schools in the grand duchy, showing an earnestness and a zeal

which we should be glad to know extended throughout the empire.

The little Republic of San Marino gives us drawings done by her pupils for the national honor and glory; plans of the city; Bonaparte offering his friendship to the Republic; St. Marinos dedicating a temple to Christ. A knowledge of the geography of San Marino is strictly required.

The National College for Young Ladies at Santa Anna, in Salvador, sends a plan of the city of Santa Anna. The silk embroidery done in the college is really beautiful. Three departments of the State send school work. Salmon Cañas gives us a Spanish grammar. Dr. David Guzman furnishes statistics of primary instruction in Salvador and specimens of the natural history of the country.

The Minister of Public Instruction of Servia furnishes a highly interesting exhibit of the organization of primary schools with the method and material of instruction. Also a geological map of the kingdom and sundry books and other publications.

Uruguay shows the desks, benches, and school furniture approved by government, and a private dealer, Ricaldoni, of Montevideo, has books on arithmetic, morals, and grammar.

Algeria gives school work from the Academy of Algiers, and from a professional primary school at Oran, showing that the French have done a good work where not long ago "school" meant no more than the Koran and the bastinado. Lessons in French and Arabic are given, methods of writing Arabic and reading are studied, with French translations, with plans and sections of schoolhouses, treatises on agriculture, and tables and works on arithmetic, etc.

French India has an exhibit from the primary schools of Pondicherry, showing pupil work and plans of schools. Martinique sends work done in four girls' schools and ten boys' schools, with an exhibit from the schools of the island in general. New Caledonia shows that the convicts are cared for educationally. Reunion sends albums of drawings and other exercises from her schools at St. Denis; and Tahiti also exhibits work done in the French schools at Papeeti.

In the British catalogue we find nothing set down for classes 6, 7, or 8. In what is called the Social Economy Section we find the reports of a few school boards, but it would not be easy to draw any inference from these as to the present state of education in England.

SCHOOLS FOR THE BLIND AND FOR THE DEAF AND DUMB.

A good deal has been done of late years for the benefit of these unfortunates to relieve the burden of existence and to supply the defective avenues of perception by stimulating to increased activity those that remain. The special apparatus used for the instruction of the blind has reached a high point of perfection. In the French

section we find maps and a terrestrial globe, on which the land, in leather, is raised above the sea level, the course of the rivers being indicated by brass wires, the lines of political boundaries by brass dots, and the geographical lines of latitude and longitude by brass twist. Congruity would seem to require that the rivers should be sunk below the land level, rather than raised above it, and this we find absolutely done in a dissected map in the United States section. Probably the brass will last longer under the pressure of many busy fingers, but the touch of the blind is generally very light. We also find exhibited a method of writing for the blind who have once been able to see; also, methods of instruction for the deaf who can speak. For the deaf and dumb, physiological sections of the vocal organs are supplied, showing the position of the tongue, lips, palate, and teeth when the various vowels and consonants are uttered. The care of the blind and the deaf is a specialty with most of the nations that have made educational exhibits, and the care and kindness bestowed upon these unfortunates is an index to the civilization of the lands in which it forms a more distinguishing feature.

CLASS 7.—ORGANIZATION AND MATERIAL FOR SECONDARY INSTRUCTION.

The limits of Class 7 are not so well defined as those of the others, as what is called "secondary" in one country may be considered "primary" in another and the higher education of some lands may be only "secondary" in others. We may know where Class 6 has its inferior and Class 8 has its superior limit, but the limits that divide each of these classes from Class 7 is a point for discussion. The writer will follow the division lines made in the various official catalogues.

FRANCE.

M. Morel, the Director of Secondary Instruction, furnishes plans and photographs of the principal lyceums and colleges in France, and an especially fine and elaborate model of the Lyceum of Laow, showing classrooms, studyrooms, refectory, dormitory, and wash-rooms. He also exhibits a district library, a small museum of art for lyceums and young ladies' schools, and sundry details of school apparatus. He gives us statistics of secondary education, and programmes for lyceums and colleges for both sexes, and a library of works published by the professors and functionaries of public secondary instruction, in all of which we notice a living spirit animating the schools and checking the constant tendency to fossilize, sometimes, unfortunately, so characteristic of educational systems.

The College of St. Barbara also shows plans, models, photographic views, and programmes.

A great many specialists make exhibits in this class. Those of in-

struments of precision, drawing books, T-squares, compasses, etc., fall more properly under class 15, while the charts and topographical work belong to Class 16. There are quite a number of methods of teaching music, success in which, however, depends far more on the teacher than on the text-book. The theory and practice of artillery figure quite largely among the material for secondary education, and we find a wooden horse contrived to demonstrate the principles of horsemanship. With the living animal at hand we fail to see what advantage is to be derived from it, although, no doubt, it is very ingenious. Models and charts designed to teach anatomy and physiology are abundant and finely executed. Excellent models and drawings are supplied for the teaching of pure and applied mathematics. The electrical apparatus belongs more properly to Class 62.

Delagrave, who publishes the French "St. Nicholas" and other periodicals designed to combine amusement with instruction, has also a number of books designed especially for secondary education, with furniture and school apparatus.

Carne exhibits gymnastic apparatus, for which he has already received decorations from several previous exhibitions.

The well-known firm of Bazin & Co., who are at present represented by Sanard, Derangeon & Co., supply maps, the weights and measures of the metric system, compasses, drawing books, and other articles that the student needs.

Croizemarie exhibits methods for school ventilation.

Rousseau & Co. have a full line of physical and chemical apparatus.

Slates (white and black), tablets, cards, tickets for "good points," as well as desks and seats, may be seen in Suzanne's exhibit.

Miss Parent exhibits a full course of music, vocal and instrumental, comprising an explanation of her method of teaching the piano, scales and arpeggios, rhythm and time, method of reading the notes in every key, an invention of the lady's own; method of transposition; and other matters.

The total number of French exhibitors in this class is ninety-four, but many of the exhibits would be more properly referred to other classes.

BELGIUM.

In Belgium there are two classes of establishments in which secondary education is given: the higher, known as the royal college or atheneum, and the lower, known as the intermediate school, which may be attached to the atheneum as a preparatory department. Both classes receive the greater part of their support from the government, and are thus strictly regarded as public schools.

The programme of the section of *humanities* in the royal atheneum comprehends Latin, Greek, French, Flemish, German, English history and geography, mathematics, elements of astronomy or cos-

mography, natural sciences, drawing, music, and gymnastics. There are also courses designed as preparations for the learned professions and for commercial life.

A museum of specimens of native and foreign productions is attached to each atheneum. It is accessible not only to the pupils during school time, but to all persons who desire to visit it in the time of vacation.

The programme of studies in the intermediate schools for boys embraces French, Flemish, German, and English, history, and geography, mathematics, natural sciences, bookkeeping and commercial law, drawing, music, and gymnastics. In girls' schools the branches of morals, domestic economy, hygiene, and needlework are added, while book-keeping is omitted.

There are also independent intermediate schools, particularly the Normal School at Louvain, for ecclesiastics destined to teach *humanities*. This is an annex to the Catholic University. There are also 54 other colleges, 69 schools for boys, and 115 for girls.

Statistics showing the relation of school attendance to population afford results very creditable to the progress of Belgian education.

Special schools of agriculture, commerce, and navigation, art, etc., are classed here, and also the industrial schools, which are yearly receiving increased attention. Weaving is a prominent feature in these schools. There are also schools for cloakmakers, tailors, printers, millers, working engineers, electricians, and photographers.

Girls are taught to paint on porcelain, silks, glass, and fans; to make and design lace; to make and cut out garments; to embroider, to make artificial flowers, and to conduct mercantile business.

In the special drawing schools are taught elementary mathematics, the study of projections, perspective, and geometry; elements of physics and mechanics; a course of hygiene and industrial economy; free-hand drawing; drawings from the round; decorative work.

Different courses of chemistry, mining engineering, metallurgy, and civil engineering have been established in various schools, according to the needs of the locality.

The drawings exhibited as pupil work from the Belgian schools give evidence of a very high degree of proficiency. Models of gymnastic apparatus, by the president of the gymnastic federation, show a very complete system of physical culture.

The industrial school of Morlauwelz makes a special exhibit in the pavilion of Mariemont of exercise-books containing many beautiful drawings made, without any assistance, by the pupils, giving testimony to the excellence of the course pursued in that institution.

Miss Marie de Pierpont has a very interesting exhibit of a system of teaching music, with a complete treatise on the laws of harmony and thorough bass. She also shows a method of finger exercise, to

secure the independent action of each upon the keyboard. This is the first time she has placed her system on exhibition.

The total number of exhibitors from Belgium, in this class, is sixteen.

UNITED STATES OF AMERICA.

The superiority of American school seats and desks over those used in Europe is the first thing that strikes us in this class. Messrs. G. A. Bobrick & Co., of Boston, make a very creditable exhibit of comfortable seats. The time is past when it was supposed to be good training for little ones to keep them in a constrained and unnatural position during the hours of study. That the brain may work freely, the body must be at ease.

The Indian Industrial School at Carlisle, Pennsylvania, excites great interest by the photographs of the pupils, showing the development of intelligence in their faces. There are also current numbers of the "Indian Helper" and "The Red Man" edited and printed by the Indian boys.

The Howard Female College of Gallatin, Tennessee, sends a portfolio of students' work deserving of special mention.

The Institute for Training Colored Ministers, of Tuscaloosa, Alabama, furnishes some interesting photographs of candidates for the sanctuary, and gives the course of studies required.

The Michigan Female Seminary of Kalamazoo, sends some well executed drawings.

The Alabama Normal School, at Tuskegee, furnishes pupil work also in the form of drawings, etc., and shows engravings of the college buildings, with a plan of the course of study.

The Philadelphia Manual Training School gives us some fine samples of the work done there, evidence of the culture of eye and hand, and of the proficiency of the pupils.

St. Stanislaus Commercial College, of Bay St. Louis, Missouri, sends very copious supplies of excellent work done by the pupils in bookkeeping and penmanship, as well as in drawing. There is also a map of the locality and plan of the college, with photographs of the students and buildings.

Other institutions have sent their catalogues and circulars, and in some cases books published for the use of the teacher.

SWITZERLAND.

As we have already remarked in the preliminary observations made upon Class 7, we have felt it generally best to follow the catalogues where we have found no distinct lines of demarcation dividing this class from Classes 6 and 8. In the Swiss catalogue, unfortunately, the exhibitors assigned to this class might as well have been referred to either of the others, and the exhibits are such

as to throw very little light on the state of secondary education in this interesting land, where there is no doubt that it is in an eminently creditable state of advancement.

The first exhibit on the list is Bæchtold's work on gardening and on the cultivation of house plants, an art and science fully worthy of all the thought given to it, as is all that contributes to make home cheerful and happy.

Swiss gymnastics have been already noticed in Class 6. Hässig's exhibit of apparatus is very complete, consisting of more than two hundred appliances, warranted to last two years at least. The clubs and dumb-bells will, of course, last much longer. Certificates of approbation from gymnastic authorities have been awarded to this apparatus.

Hofer and Burger show technological drawings, with historical and geographical charts.

Kradolfer shows some fine specimens of handwriting and book-keeping, with artistic drawings executed with the pen.

Lussy exhibits musical exercises for the piano, with a treatise on musical expression in French, English, German, and Russian; also on musical rhythm in French and Russian, with an interesting history of musical notation.

Orell, Füssli & Co. display the books used in secondary instruction, comprising grammars of different languages, a course of calligraphy and of history, and chrestomathy, with a course of literary reading.

Trachsler, Wettstein & Co. show gymnastic apparatus for the use of societies as well as of schools.

BRAZIL.

The Baron de Macahubas, whose labors in primary education have been already spoken of, has found time to prepare an excellent cosmographic sphere for higher classes, with a written guide, by which the small figure which our terrestrial planet plays in the universe may be brought to the comprehension of the wondering pupil. He has also turned his attention to the teaching of music to a numerous class by means of charts.

The Lyceum of Arts and Trades of Rio Janeiro sends books and publications relating to the institution, and affording very gratifying statistics as to the progress of education in the Empire under the fostering care of one of the greatest monarchs of modern times. The lyceum also sends some highly finished drawings and paintings executed by the pupils. Great praise is due to the gentleman in charge of the Brazilian pavilion for the taste and judgment shown in the arrangement of exhibits.

Among the numerous exhibits of books and apparatus by dealers, we may notice the method of teaching Portuguese exhibited by Ble-

lagarde, the treatise on logic by Briggo the musical treatise; and method of playing the flute by Costa, jr.; the sacred history of Mme. Léal; the analytic grammar of Massa, and also that of Ortiz & Pardal; the method of teaching English by Oliveira, and the mathematical course of Ottoni. A. M. Pinto, of Rio de Janeiro, publishes a fine geographical series, with special reference to the geography of Brazil; and H. Ribeiro has a complete exhibit of school books, readers, grammars, geographies, etc. Viera has historical charts showing contemporaneous events.

OTHER COUNTRIES.

The contributions of Chili to Class 7 consist chiefly of musical compositions and systems of teaching music displayed by nine different exhibitors.

Denmark shows some very pretty pupil work done in Madame Klein's School of Drawing and Industry, at Copenhagen.

The Coöperative Commission at Quito, Ecuador, exhibits stuffed birds.

There are some charts of calligraphy shown from Spain, and a chart of colonial history from the Philippine Islands.

Italy sends some grammars, a French grammar for the use of Italians, and a new method of studying Greek. There is also an elementary course in decorative art, and a crystal vase, containing the principal geometrical solids wrought in wood.

Japan has a fine large map of the Empire, carefully drawn. The Minister of Public Instruction also makes a large exhibit relating to secondary education, models of schoolhouses, apparatus, and tools. The drawings executed by the pupils are very interesting. There is an evident truth of expression in the faces, although the subjects are rather quaint and picturesque than what we should call beautiful. A style of pencil-drawing—the sketch method so much practiced in England by young ladies a quarter of a century ago—has been evidently revived by some old emigrant professor of art among the Japanese. It produces satisfactory results with a minimum of actual labor. Statistics furnished show very cheering prospects for education in Japan.

The Grand Duchy of Luxembourg shows water-color drawings and pen sketches, with apparatus for teaching perspective. Norway shows zoölogical charts and a method of drawing. Holland presents the regulation geometrical solids in wood. The Colonial Museum of Lisbon exhibits the productions of the Portuguese Colonies. Roumania has four exhibits by music teachers and a course of study in German. Russia sends a calculating machine.

San Marino exhibits a topographical chart of her territory and a treatise on physics and chemistry.

Salvador devotes most of her exhibit in this class to the study of

law. She has eight exhibitors who give us the code either in general or as it concerns some special social or military department. Other exhibitors give us works on rhetoric, mathematics, book-keeping, the history of Central America, and the art of teaching.

The Minister of Public Instruction of Servia makes a very fine exhibit of pupil work from the public school of Belgrade, including free-hand drawing, ornamental and architectural designs, tinted plans and elevations, woodwork, and the inevitable geometric solids.

Uruguay exhibits some works on the theory and practice of teaching and other instructive literature.

Algeria shows the course of study pursued in the National School of Industry, at Dellys, and the *Ligue de l'Enseignement*, at Algiers gives some fine views and drawings of the girls' secondary school, with apparatus and pupil work, instruments, and models. De Galland, of Algiers, gives a general history of the college and lyceum at that place and of the smaller lyceum of Ben-Aknown. E. P. Guerin exhibits a key to the Arabic language and an Arabic manuscript entitled "The Awakening of Creation." We find also a method of perspective by Lestrade.

From Gaboon, Congo, the Rt. Rev. Mgr. Leberre, Bishop of the Two Guineas, sends works in the native language, as also does Joseph Reading, of Baraka. From French India we have a collection of Tamul songs. There are also some books from Tunis, referred to this class.

CLASS 8.—SUPERIOR EDUCATION.

FRANCE.

France has a very full exhibit of superior education in which, with the single exception of Belgium, none have even attempted to rival her display. Whether foreign nations would appear to disadvantage or not in comparison with her, can never be known as the result of this Exposition, as there has been so little pretense at competition. Moreover, she has appropriated all the spare wall space in every building not strictly national to the display of some one of her schools, so that when you walk through the Oriental Art Gallery in the Trocadéro, for instance, your attention is abruptly called from the contemplation of many-armed Hindoo divinities and the mysteries of the cave of Elephanta to the topographical designs of some French school of engineers.

We regret to see that Volapük still holds its own as a branch of "Superior Education," and is, moreover, attended by an ever-increasing brood of "international" languages. Their number and variety are sufficient evidence of their insufficiency and want of vitality. Let us hope that they will die out with the present century.

The exhibit of the Director of Superior Education very properly holds a prominent place. A beautiful model in plaster of the great Parisian University, the Sorbonne, with its new extensions, attracts general and well-deserved admiration. This is the work of the noted Parisian architect, M. Nénot. Other architects of distinction have furnished models, plans, elevations, and photographs of beautiful buildings consecrated to the uses of higher education throughout the various provinces of France. Apparatus, publications, anatomical preparations, and mineralogical specimens are furnished in sufficient quantities to stock a museum. The geological charts, with the fauna and flora of the past ages, give the results of continued research in this most interesting department of knowledge. The archives of the Museum of Natural History at Lyons afford mental food that it would take weeks or months to digest. Chemical preparations also open another interesting department of study. Added to these are annals innumerable, those of the Parisian and provincial observatories being especially attractive. The meteorological observations are abundant, and will be of use some day, perhaps, should meteorology ever become an exact science.

The Minister of Public Instruction and of the Fine Arts makes a splendid display of the results of archæological and ethnological research in various parts of the world. From Cairo, besides the usual reports, we have the tomb of Sêti and a collection of textile fabrics, a restoration of the temples of Luxor and Dîr-el-Medineh at Thebes, drawings of Coptic monuments, sketches from the tomb of Rekhmara; Greek inscriptions from the temple of Philoe, and a copy in colors of the tomb of Queen Tisti.

From the French missions in Cambodia come pillars, statues, and pottery. The Cambodian divinities are hideous, but interesting. From Tunis come heads of the Roman Emperors, Claudius and Augustus, and Punic inscriptions. Ethnographic collections are also supplied from the high table-lands of Central Asia, presumably the cradle of the Aryan race. Collections equally interesting come from the new world, the upper valley of the Orinoco. Armenia and the Caucasus contributed their exhumed treasures. A statue of Victory, discovered in Samothræ, is furnished us by the French consul. We have also an ingenious restoration of the palace of Darius, and another of the terraces and towers of the pyramid of Pîmanacas, an ancient palace of Cambodian kings. A new map of the little-known land of Thibet is highly instructive. From Borneo come various specimens of native weapons. Silverwork and cloth of silk and gold are sent from Malacca. Here, too, we may see the model of a cave-dwelling at Hadedj, in Southern Tunis, and another, reduced to the twentieth of the size of the original, of a megalithic monument from a neighboring region. The West African mission sends ethnographic collections made in that interesting region. Side

by side with these nations of the Torrid Zone, Lapland and Greenland contribute their archæological remains. The temple of Horus at Edfou is represented in its actual state and as restored. The French consul at Bagdad furnishes the results of excavations made on the site of an ancient Chaldean city. From nearer home come the arms, vessels, and jewels found in a Merovingian cemetery.

In mineralogy and geology numerous specimens are exhibited. Fossils and rocks from Andalusia; minerals from Iceland and the Färöe Islands; others from Norway.

The Ethnographic Museum of France exhibits the details of provincial life and costume in a very entertaining manner. Ancient instruments of music, banners and medals for pilgrimages, models of cave-dwellings in La Vendée, small images of prehistoric heroes, amulets, and the apparel and head dresses of various provinces of France, with the adjacent provinces of Spain, Flanders, Alsace and Lorraine, form a curious and delightful display, among which those interested in race history may spend many profitable hours.

Combined with this study, reference may be made to the publications of learned societies, from 1878 to 1889, which form an imposing array of lore, and seem to tell us that the moments of the past have been explored to some purpose, so that as we advance towards the future the past becomes ever more and more intelligible.

The national archives of France are now on exhibition, and, although we may be glad to have a Guizot to help us read them, curiosity may be satisfied by a view of the originals. There are also catalogues of the public libraries.

Societies for various literary and scientific objects, and many dealers in schoolbooks and apparatus have exhibits belonging to this class. Treatises on all the known branches of science and a great deal that is merely conjectural find their place here. Microscopic work and apparatus abound. Anatomical treatises, charts, preparations, and models are equally plentiful. The spectroscope has its work displayed, and stuffed birds and beasts, with preserved insects and reptiles, amply illustrate the zoölogical researches of the current period.

BELGIUM.

Some of the Belgian institutions of higher education are under State control, others are exempt from it. Among the latter are the Universities of Louvain and Brussels. All the Belgian Universities have four faculties: (1) philosophy and literature, or what in college parlance is known as "the humanities;" (2) science, mathematical, physical and natural; (3) law, and (4) medicine. The University of Louvain has in addition the faculty of divinity. All these faculties are entitled to give degrees, according to the usual custom. The exercise

of the professions of law and medicine is restricted to those who have been successful in obtaining university degrees.

Attached to the scientific departments of the universities are technical schools in which engineering diplomas are awarded. At Brussels, the Polytechnic School has courses of civil engineering, mining, metallurgy, chemistry, and mechanics or architecture. At Ghent, the School of Civil Engineering and the School of Arts and Manufactures train candidates for official service in the department of roads and bridges, also for civil engineers, overseers of public contracts, architects, and working engineers. At Liège, the School of Mines, the School of Arts and Manufactures, and the Institute of Electricity afford the necessary training to overseers of mines and mining engineers, manufacturing engineers, and electricians. At Louvain, the School of Arts and Manufactures, of Civil Engineers, and Mines awards diplomas for successful study in these three branches, as well as to those who complete courses in chemistry, architecture and civil constructions. Superior schools in agriculture and brewing confer special diplomas.

The various courses in which engineering is taught occupy, for the most part, four years, of which the first two are devoted to preparatory and the last two to special studies.

A State veterinary school has been established at Cureghem-lez-Bruxelles. The course is at once theoretical and practical. It includes physics, chemistry, botany, the elements of zoölogy, descriptive and comparative anatomy of domestic animals, general anatomy, physiology, *materia medica*, general therapeutics, general pathology, pathological anatomy, special pathology and therapeutics, surgical pathology, zoötechny, etc. The course of studies lasts four years.

A State Institution of Agriculture at Gembloux will more properly be noticed as belonging to Class 73.

There is a Higher Commercial School at Antwerp, having for its object instruction in the theory and practice of commercial science. It has a commercial office annexed, in which mercantile business and banking are practically illustrated. There is also a museum of specimens of natural and manufactured commodities, with a laboratory and a mercantile library. The course comprises practice in the commercial office, including business correspondence in French, English, Dutch, German, Spanish, and Italian, the history of articles of commerce, political and statistical economy, commercial and industrial geography, general history of commerce and industry, the tariff laws, commercial and maritime law, the principles of international law, and maritime constructions and armament. The course of studies lasts two years, and a diploma is awarded for its successful prosecution.

The military school has been the subject of careful legislation. It affords instruction in artillery practice, military engineering, and

tactics. There is a four-year course. Horsemanship is a special branch taught at Ypres.

The works of Dr. Burggräve, emeritus professor in the University of Ghent and the founder of the dosimetric system in medicine, are on exhibition, comprising 62 volumes, in manuscript as well as print. The author's reputation is a sufficient guarantee as to the worth of his books.

Professor Damssaux has some interesting works on the theory and practice of agriculture, with reports as to its present condition, etc.

Captain de Heusch, professor in the military school at Brussels, has a series of historical works on the rise, progress, and present state of the military art, tactics, etc.

Professor de Monge has equally exhaustive works on the subject of literature and morals, and, in short, the Belgian exhibit in Class 8 is a vast repository of information on all matters connected with higher education.

UNITED STATES OF AMERICA.

Very few examples of what we do for higher education have found their way into this Exposition. A stray catalogue or so, probably contributed by private hands, is all we met with in general to represent our principal houses of learning. There are several exceptions, however, that deserve notice.

Prof. C. Wellman Parks, the superintendent of this department, who has done much to render it attractive, exhibits a highly interesting chart, showing at a glance the number of students attending each of our centers of higher education, the number of teachers, the revenue, and the religious complexion of the establishment. This is accompanied by a large map of the United States, showing the location of these institutions of learning, and of the railroads by which access may be had to them. An exhibit, also, of periodicals published by students completes this useful work of reference.

Perhaps the most unique object of interest in the whole Exposition is the photographic map of the Normal Solar Spectrum, made with the concave grating, by Prof. H. A. Rowland, of Johns Hopkins University. The daily increasing interest in spectroscopy and the delight felt in the wonders of "the new astronomy," which the spectroscope has revealed, seem to show an activity of mind in this direction which can not fail to materialize in still more entertaining shapes.

Some excellent scholars' work is provided by the Alabama Polytechnic Institute, the Massachusetts College of Pharmacy, and the Rensselaer Polytechnic Institute. That sent by the last-mentioned institution is particularly interesting, embracing, as it does, views of structures actually erected by the students as the result of training received there.

College papers may afford some indication of intellectual activity among students, although experience shows that it is not the most profound thinkers who generally find vent for their reflections by these channels. Some excellent specimens of such publications, however, are represented in the Exposition. The American Institute of Electrical Engineers, of New York City, sends current numbers of "Transactions." Carlton College, Minnesota, sends "The Carltonian." Dartmouth supplies bound volumes as well as current numbers of several of its interesting publications, "Dartmouth Lyrics," "The Aegis," "Dartmouth Literary Monthly," and "The Dartmouth," with an illustrated book entitled "Dartmouth and Vicinity." The Eclectic Medical College of Cincinnati, sends current numbers of the "Eclectic Medical Journal." The Engineers' Club of Philadelphia, current numbers of "Proceedings." The Historical Society of Montana furnishes copies of "The Heart of the Continent," "Great Falls Tribune," and "West Shore." The Indiana State Medical Society send four volumes of "Transactions." Lafayette College, Pennsylvania, gives us current numbers of the "Lafayette" and one volume of the "Melange." The Lehigh University sends the "Lehigh Burr." The Medical Society of Kings County, Brooklyn, exhibits eight volumes of "Proceedings" and two volumes of their "Medical Journal." The New Haven Historical Society furnishes four volumes of their "Papers;" the New York Medical Association, four volumes of "Transactions." St. Stephen's College, New York, sends current numbers of the "Churchman;" the Stevens Institute of Technology, Hoboken, current numbers of the "Stevens Indicator" and other students' publications; Swarthmore College, Pennsylvania, current numbers of the "Swarthmore Phoenix;" the University of Notre Dame, Indiana, current numbers of the "Scholastic." Upper Iowa University furnishes bound volumes of the "Fayette Collegian." Ursinus College, Pennsylvania, sends three numbers of the "College Bulletin." Virginia Historical Society gives us two valuable volumes of "Spotiswood Letters" and "Proceedings." Washington and Lee University furnishes us with two volumes of the "Southern Collegian" and the Worcester Polytechnic Institute exhibits current numbers of the "W. P. I." From an inspection of these various publications, there is reason to hope that college literature is taking a higher flight as the years advance, and will become more and more a means of useful training.

All that can be gathered from photographs—the commodious character of college buildings, the complete array of apparatus, and the intelligence that irradiates the cultured countenance—may be sought and found in those furnished by several of our prominent institutions, the following among which have sent views of their buildings and those who frequent them: Amherst College, Massachusetts, Cornell, New York, Dartmouth, New Hampshire, General Society Me-

chanics and Tradesmen, New York, Haverford College, Pennsylvania, Heidelberg College, Ohio, Kentucky University, Lafayette College, Pennsylvania, Public Library, West Brookfield, Massachusetts, Rensselaer Polytechnic Institute, Troy, New York, St. John's College, Annapolis, Maryland, St. Joseph Diocesan College, Teutopolis, Illinois, St. Stephen's College, Annandale, New York, Stevens Institute of Technology, Hoboken, New Jersey, University of Virginia, Waltham Public Library, Washington and Lee University, Woburn Public Library, Worcester Polytechnic Institute, Young Men's Christian Association, New York, and Young Men's Christian Union, Boston.

Many other institutions of learning have sent catalogues, textbooks, annual reports, blanks, etc., but nothing like a fair idea of American higher education can be gained from this exposition.

Sidney M. Smith sends a most interesting series of photographic views, by Mathews, of the Lick telescope, the observatory, and the work done there.

E. D. Cope, of Philadelphia, exhibits two fine plaster casts of extinct mammals of the age of the Lower Eocene, to which the names of *Phenacodus venticolum* and *Stryacotherium venticolum* have been given.

Prof. Henry S. Osborn, of Oxford, Ohio, presents large wall maps of Palestine and part of Syria, in which all the results of modern research are embodied, forming a valuable aid to the student of sacred history.

SWITZERLAND.

It is difficult to find out why the Swiss should catalogue, as belonging to this class, a simplified elementary geometry for popular use, with colored figures. The work has its merits, no doubt, but it does not belong to the province of higher education.

The School of Arts and Female Labor of Zurich covers so much ground that it might be placed anywhere in the educational classes. We are glad to find housekeeping and cookery exalted to an honorable rank, however, and, in addition to these useful branches, this school teaches painting, drawing, accounts, mathematics, correspondence, and the languages. The specimens of painting and drawing on exposition are attractive and extremely creditable. If the housekeeping and cooking taught here are equally successful, we congratulate those gentlemen who will be wise enough to select their partners for life from this school.

The International League for Sunday Observance exhibits its publications, circulars, charts, and results in this class. It is engaged in a cause that would be advantageously prosecuted here in Paris. The labor done here on Sunday is evidently unprofitable. If the work people took their regular Sunday rest, as they ought to do, they would probably accomplish much more in the course of the week.

Orell, Füssli & Co., of Zurich, exhibit books of instruction in physics, architecture, decorative art, civil engineering, geography, and commercial arithmetic. This firm is keeping up its well-known character for supplying first-class text-books at a reasonable price.

OTHER COUNTRIES.

On entering the magnificent pavilion of the Argentine Republic, we are confronted at once with an immense topographical map, curved in due proportion to the curvature of the earth's surface, and exhibiting not only Argentine, but also Paraguay, Uruguay, Chili, and the neighboring islands in the Atlantic, Pacific, and Antarctic Oceans. The Andes and other mountains stand out in bold relief above the vast plain of the Pampas. Moreover, the Republic has no less than one hundred and sixty-nine exhibits of books, on various scientific and literary subjects, both in prose and poetry.

One exhibit is recorded in this class in the name of Hungary, and it is doubtful whether it belongs here or not. It consists of the description, illustrated by drawings, of a locomotive of great speed and on a novel system.

Bolivia's exhibit is ethnological, relating to the aborigines. There are some Indian mummies with petrified eyes, etc.

Brazil has a fine exhibit from her School of Mines and her Geographical Society sends a wooden model of an immense meteorite, found in Bahia and now in the National Museum at Rio de Janeiro. Some fragments of the meteorite accompany the model. There are also collections of insects, etc.

The Commissariat of the Exposition of Chili, at Santiago, sends a fine collection of the text-books used in the schools. The School of Arts and Trades sends models of a turbine. The University of Chili furnishes interesting photographs; and a collection of antiquities, belonging to the stone age, is sent by a private exhibitor, Julio Besnard, of Santiago.

From Ecuador we get a case of butterflies and some ethnological curiosities.

In the Mexican pavilion is shown some excellent work in topography, equal to anything of the kind in the Exposition. Also a very fine collection of Mexican birds and mammals, stuffed, made by Henry L. Ward, of Rochester, New York.

Spain has an exhibit of crystallographic models and specimens for the study of germination; also, the plans and details of a system of water supply and a method of short-hand writing.

Greece exhibits a cephalometric chart and some works on geography.

Italy provides an historical and descriptive guide to the "Divina Commedia;" also, a grammar for the use of higher classes, an album

of plants for the study of botany, and a new system or application of lithography.

The Minister of Public Instruction at Tokio, in Japan, sends a very creditable exhibit, calculated to raise in esteem the educational system of that interesting country. Here are works on law and history, photographs, statistics, regulations, and most instructive documents in relation to earthquakes.

The exhibit of Luxembourg is archæological in its character.

Norway reports a scientific expedition into the Northern Seas and shows some anthropological charts.

Roumania shows the immense jaws and teeth of an antediluvian animal, four books on linear perspective, and some petrifications.

San Marino displays her archives and antiquities and her treaty with the Kingdom of Italy.

Salvador sends some results of manual labor from her penitentiary. The writer is unable to view these in the light of higher education.

The Minister of Public Instruction for Servia sends the records of the Royal Academy; literary works published by the Glasnik Society; work done by pupils of the Society of Sciences connected with the University of Belgrade; topographical drawings of various localities in Servia; water-color paintings representing several types of costume and domestic interiors of Servia; and some curious drawings on ethnological subjects.

Venezuela is chiefly ethnological, also, in her exhibit under this class. The models of Indian lake-dwellings are particularly interesting.

Algeria sends herbaria, with studies on the indigenous and cultivated plants of the country; fossils formed by deposits of phosphate of lime; and some ethnographic curiosities. There is also an apparatus for demonstrating experimentally the laws of gravitation, a work on chemistry, and a display of matters connected with artillery by the society formed for that purpose.

Other French colonies figure largely in Class 9, but we must not draw conclusions regarding the state of higher education in Cochin China or Gaboon, Congo, from the circumstance. Where French industry has made collection of curiosities in any particular colony, we find it put down to the credit of that colony. Valuable exhibits in the departments of ethnology, archæology, geology, zoölogy, and botany have been sent, not only from the two colonies mentioned, but also from Guadeloupe, French Guiana, the Windward Islands, French India, Madagascar, Martinique, Mayotte, and Comorin Nossi-Bé, New Caledonia, Reunion, St. Peter and Miquelon, Senegal, and Tahiti.

Annam-Tonkin sends samples of seed and other articles of merchandise, besides a fine collection of curiosities.

Cambodia, land of the tropical sun, sends her umbrellas and palanquins, and other products of the national industries.

Tunis is rich in the display of antiquities and the results of excavations made recently in various localities. Carthage, the last successful rival of Rome, furnishes mines of unlimited treasure to the archæologist.

CLASSES 6, 7, AND 8.

The difficulty of separating the educational classes has suggested, even to the French, who have been the ones to draw the lines of demarkation according to their own views, the expediency of treating them in combination. Messrs. Hachette & Co., for instance, have an elegant classical pavilion in the *Esplanade des Invalides*, where they display school apparatus and text-books for all degrees of education, from the wire and bead frame to teach numeration up to the alembics and crucibles of the laboratory, and the classic models of physical beauty designed for the practice of the young painter or sculptor.

Here, too, belong schools for special industries, such as the manufacture of flowers and feathers, polytechnic schools, and all institutions which occupy the doubtful ground between general education and the apprenticeship to some particular trade. And it appears difficult to draw the line.

A manual for the use of capitalists shows rich men how to make the most of their resources, but perhaps not how to derive the greatest amount of happiness from the use of them.

The exhibit of ancient embroidery is among the most interesting features classed here. There is Egyptian tapestry belonging to the early centuries of the Christian era, much of it having an historical as well as an artistic value.

From Egypt, ceilings frescoed in arabesques, are placed here.

Holland furnishes reports from two professional schools, with work done by the pupils, as blacksmiths, carpenters, painters, and cabinet-makers; also, an exhibit from an industrial museum and the publications of the Dutch Society for the Encouragement of Industry.

One of the curious things in the display of statuary for use as models is the difference of opinion as to what public decency requires. The classic statues for the use of young ladies' schools may be had either "draped," "with a leaf" or "entirely nude," according to the discretion of the school administration.

CLASS 9.—PRINTING AND BOOKS.

Letterpress seems to have reached perfection several years ago. It is true there is a larger amount of fine printing done now than ever before and excellently printed books are so cheapened as to

have driven inferior grades out of the market, but when we compare the best printing done nowadays with the best done fifty years ago we can only find that it is less costly. Styles of fancy type are every day invented, but these are used only for cards and advertisements and only noticed by experts.

UNITED STATES OF AMERICA.

The names of American publishers "familiar in our ears as household words" figure conspicuously on the brilliant showcases of the room assigned to them. Houghton, Mifflin & Co., of the Riverside Press, Cambridge, Massachusetts, has absorbed the once well-known firm of Ticknor & Fields, whose very name, as well as that of the present firm, is a guarantee of the literary merit of its publications. As the firm state, "it is not the ambition of the house to publish a multiplicity of books, but to publish the best books, the best in literary quality and the best in every detail of manufacture, published in any language, in any country." Of how nobly the firm have attained the object of their ambition, the selection, small as it is, which appears on the shelves allotted to them may convey some idea. Here we find magnificent editions of standard American authors: Longfellow and Holmes, Hawthorne, Whittier, and Agassiz, Emerson and Howells, with others less widely known. The splendid *édition de luxe* of Omar Khayyam deserves notice, both here and in the next class, for its superb binding. It cannot be said to belong to the department of letterpress printing at all, as the text is combined with the grand illustrations in phototype. We do not know how Omar's laudation of the grape could be reconciled with his Mahommedan temperance principles, but men often find in religion itself an excuse for various indulgences which to outsiders would seem diametrically opposed to the system to which they adhere.

Appleton & Co. seem to devote themselves more to science and to the diffusion of useful knowledge. Their American Cyclopedia alone would entitle them to celebrity. In the preparation of a book of this kind, as much judgment must be exercised in determining what to reject as what to embody in the work. The antiquated and exploded systems of science still perplex those who consult the older cyclopedias, and even in modern investigations there is much that must receive the verdict of "not proven." But the editors of the American Cyclopedia seem to have found out whereto draw the line. The Popular Science Monthly issued by this firm gives all the latest theories on scientific matters in a readable shape, and all kinds of conflicting views are put forward by different writers, affording considerable mental exercise to the reader. "Picturesque America" is worthy of its poet-editor, William Cullen Bryant, and of the land whose mountains and cataracts are depicted upon its pages. Ban-

croft's labors and Fenimore Cooper's gilt-edged Indians, who, after all, are as real as "Buffalo Bill's" and ten times as attractive, have earned a position on Appleton's shelves, and those who like to reflect on the "unknowable" may find Herbert Spencer and Darwin ready to perplex their souls.

Gebbie & Co., a firm of more recent date, are distinguished for the beauty of their engravings, etchings, and photogravures. They deal in books that admit of copious illustration, the matter varying from Burns's poems to the Imitation of Christ and from obstetrics to the Apocrypha of the New Testament. They exhibit the photogravure process in all its stages, forming a most interesting series. Their *éditions de luxe* must be noticed under the head of bookbinding in Class 10.

Iverson, Blakeman & Co. deal chiefly in school books, excellent, of course, as we all know, although not so cheap as those published in Europe. Perhaps we have not the same reason to require cheap books, and can better afford to buy for our children what will gratify the taste and preserve the eyesight, while solid knowledge is imparted, but in the large cities of our seaboard States there are dangerous elements at work, to cope with which a cheaper form of education might be a desideratum.

G. C. Merriam & Co., are the publishers of Webster's Dictionary, whose merits are too well known to need comment.

George Barrie exhibits some works unique of their kind, in particular Marshall's portrait of Longfellow, a beautiful tribute of reverence to the greatest of our poets. "The Art Treasures of America" is a grand collection, illustrated by one hundred and sixty photogravures and several hundreds of wood cuts, facsimiles and thumb-nail sketches, while appended is an alphabetical index of ten or twelve thousand of works of art in the United States. "The Hierarchy of the Roman Catholic Church in the United States" is by Maurice Francis Egan, formerly editor of the New York Freeman's Journal, and at present professor of literature in the University of Notre Dame, Indiana. No one that the writer knows is better fitted to compile biographies so interesting to a large portion of our population. "The Works of Molière," with illustrations and English text, will commend itself to all lovers of comedy.

Estes & Lauriat exhibit some splendid *éditions de luxe*, in various departments: history, fiction, poetry, etc. They give us English and French works; George Eliot, Keats, Moore, and Carlyle, together with Victor Hugo and Duray. America is not left out, however; her birds and flowers form the subjects of several finely illustrated works.

The Lippincott Company are here, of course, opening their well-known special walks to the reader. Biography, medical literature, and some choice poetry form the staple of their exhibit. We need

not mention their well-known Worcester's Dictionary, nor their course of school readers, diffused as they are so generally throughout the United States. Their magazine, also, finds its place on every library table.

The D. Lothrop Company display works of popular instruction for young and old, occupying the debatable land between mere school-books and the higher classes of literature. Indeed, the higher classes are represented by many of their publications, particularly in the domains of poetry. Their *éditions de luxe* are beautifully illustrated with photogravures.

Barnes & Co.'s schoolbooks deserve to be as well known in Europe as they are in America. The geographical series is particularly bright and attractive.

L. Prang & Co.'s chromo-lithographs are superb. Hours might be profitably employed in the study of their reproductions of oil paintings, water colors, etc. Among their art books, "The Native Flowers and Ferns of the United States" is particularly attractive to the large and increasing body of lovers of nature.

Taintor Bros. & Co. have an excellent course of schoolbooks, with popular musicbooks for divine worship. Taintor's Guide Books are a useful series for the tourist.

Robert M. Lindsay has a display of fine etchings.

McClurg & Co., of Chicago, have done much to make that healthy young Western city favorably known in Europe as well as in the United States. They have grown up with it and have partaken of its magnificent development. In their present display, the useful and the practical preponderate over the merely ornamental. Music, however, finds a place for its peculiar literature in Upton's "Standard Operas."

Dodd, Mead & Co. deal in literary oddities. They have Pepys' Diary and General Greely's Notions of the Weather.

Henry Carey Baird & Co. publish works on various industries, including cosmetics and perfumery, which might be characterized by some as forms of idleness rather than of industry, but people make money by them nevertheless.

Frederick A. Stokes & Bro. show some highly meritorious etchings.

John Wiley & Sons devote their attention to publications relating to the science and art of civil engineering, whose importance is making itself felt every day, and which is the true pioneer of civilization, establishing railroads across the desert and mountain fastnesses and making even the lately discovered African rivers avenues of access to the interior of the Dark Continent. The civil engineer should provide himself with Wiley's library, and he will need no other works of reference.

The Century Company have a magazine which occupies the first rank among periodicals, while their "St. Nicholas" is as welcome

in the nursery as the "Century" is in the parlor. And many children of larger growth might be content to stay in the nursery for the sake of the saint. The books they publish are remarkable for the living interest they inspire.

The publications from Johns Hopkins University in the higher walks of science are worthy of that home of learning.

The writer can only notice briefly the meritorious book-trade publications, the text-books of the University Publishing Company, the American Bookseller, the Dramatic Mirror, Contanseau's Monthly Bulletin, and the School Bulletin Publications, all of which are excellent in the peculiar field of each.

The Photo-Electrotype Engraving Company exhibit fine examples of their work and explain the interesting processes by which the creditable results are attained.

Brentano's publishing house belongs as well to Europe as to America and is of world-wide celebrity.

About one hundred and sixty American periodicals are on exhibition. These are devoted to every conceivable interest, from "The Butchers' Advocate" to the "Evangelist" and from the "Brewers' Journal" to "The National Educator."

The Navy and War Departments of the United States also send their reports and other publications and some private exhibitors display works which seem to have found no regular publisher. Chief among these is Austin's System of Chemical Labels, which is shown in manuscript form. It unfortunately arrived too late to find its way into the catalogues. The system is unique, and has received favorable attention from practical chemists, not only in the United States, but also in France. Harvard and the Sorbonne alike appreciate its merits. It is to be hoped that the accomplished author may soon find a publisher able and willing to give this manuscript the celebrity it deserves.

This notice would not be complete without mention of the name of Mr. E. Terquem, who takes charge of the display of American publications and whose taste in arranging them, as well as his courteous attention to those who wish to examine them, has added much to their attractiveness.

A very useful work in the commercial world is Armstrong & Knauer's "Manufactures of the United States for Domestic and Foreign Trade," which contains in compact form a mine of information. It is not an advertising enterprise in any sense, but a cyclopedia for general reference.

GREAT BRITAIN.

Under the name of *Grande Bretagne* all the British Islands seem to be included, although the title properly belongs only to the largest among them.

The British exhibit of books and periodicals is second only to our own. The Galignani Library is a collection from sixteen different publishing houses, some of whose names, as those of W. & R. Chambers, for instance, have long been treasured in American households. The Oxford University Press exhibits the New Testament in vest-pocket size; but, though so small, the print is beautifully clear, and legible to eyes of average powers without glasses. The smallest edition of the Bible is also to be seen here. In this well-chosen library we find all the good old English classics, works of the literary masters that have flourished in the reigns of Elizabeth, Anne, and Victoria. Why should the incumbency of a lady on the British throne have been always favorable to literature or is the coincidence merely accidental?

The files of the Illustrated London News are chiefly interesting as showing the progress and development of the art of wood engraving. This progress has been by no means gradual. What poor Tom Hood once called the "old scratchy" style prevailed until some time in the seventies, and then a remarkable improvement took place, a softening of outlines, a gradation of shades, of which we still enjoy the results. Original sketches by eminent artists, made for this periodical, are highly interesting and valuable.

The British and Foreign Bible Society publish the Holy Scriptures in two hundred and seventy-nine languages and dialects, and of those a vast number are to be found in their handsome bookcase in this Exposition. The scoffs so frequently uttered nowadays against the sacred volume render it more than doubtful whether it was a prudent step to distribute it so promiscuously among those who can only read the letter without discerning the spirit.

Augener & Co. publish classical and modern music and a course of instruction which comes in a cheap form, as well as in *éditions de luxe*. The "British Trade Journal" appears in three languages, English, French, and Spanish. Caslon & Co. exhibit the latest styles in printing type and patent stereo-plates. The Chromo Lithographic Art Studio shows fine specimens of its work. Griggs has also an exhibit of chromolithography and kindred arts. Morgan & Co. display their commercial and technical periodicals, and Riviere & Son have some fine illuminated volumes of poetry and literary curiosities in *éditions de luxe*.

FRANCE.

As might be expected, since France is at home here, her display of books and periodicals is very full. She still sticks to the peculiarities of her printing type, giving the capital C, for instance, the same finish at both extremities of the curve, which renders it liable to be mistaken for a G. Cheaper editions are abundant, which is rather a good sign than otherwise. At the same time there are publications

on which every luxury known to the trade has been lavished. Among the exhibitors we may notice Cohn & Co., medalists of previous expositions, who show a grand array of schoolbooks, music and wall maps; the old established house of Delalain Bros., which antedates the revolution and which publishes a high order of University literature, classic and scientific; Gauthier-Villars & Son, printers to the Polytechnic Institute and other learned bodies, who also can claim a lengthy record of usefulness, wanting but little of a century; Firmin-Didot & Co., who make a magnificent display of engravings and other art work; Gruel & Engelman, whose editions are veritable triumphs of execution; Hetzel & Co., who devote themselves to the needs of the youthful imagination, and publish Jules Verne and other scientific extravaganzas; Jouvet & Co., who make a specialty of more solid educational works; Henri P. Laurens, who offers a splendid show of works on art, beautifully illustrated; Maguier, whose publications are still more choice and who reproduces the luxurious style of Louis Quinze; Plon, Nourrit & Co., the members of whose firm wear the decoration of the Legion of Honor and deal in the higher walks of literature; Reinwald, who devotes himself to science as applied particularly to the practice of medicine and surgery, and who has also been decorated alike by his native country and by foreign powers, and Testard & Co., who have fine editions of the French classics, Victor Hugo, Balzac, and Molière, with original illustrations of great value and interest.

All the above are Parisian firms. From the provinces several fine exhibits are also made. Burdin & Co., of Angers, display scientific works and have books in various oriental languages, a delightful collection for the philologist. Cagniard, of Rouen, has reproductions of antique volumes and an interesting series of historical and geographical works relating to his province—Normandy. Danel, of Lille, exhibits samples of chromos, etc. Jacquot, of Nancy, is a music publisher and deals especially in the music of Lorraine. Privat, of Toulouse, furnishes us with the literature and history of Languedoc, that land of minstrelsy and romance, and Thézard, fils, of Dourdan, has a fine display in the departments of architecture and decorative art.

All these and many more, the whole number of exhibitors being one hundred and eighty-seven, furnish material for long years of study and reflection and convey a pleasing idea of the present state of French literature.

BELGIUM.

The provinces which now form the independent kingdom of Belgium were, in the fifteenth century, if not the originators, at least the foster parents of printing and the sister art of wood-engraving, which were prosecuted in spite of the tyrannies of Spanish and Aus-

trian despotism. The independence of the nation, achieved within the present century, has given a new impetus to the cherished arts, and in their present prosperity results are achieved that place Belgium on a par with the rest of the civilized world.

The Circle of books and printing and of the Kindred Professions, of Brussels, has a fine general exhibit of engravings, books, and journals, globes, maps, and atlases. A number of well-known publishers belong to this circle, and their issues are eminently adapted to meet the needs for which they are designed. Among them are Bourlard, who does the government printing; Bouwens, the distinguished engraver; Claessen, who makes the industrial arts his specialty; Decq, who deals in works of technology, jurisprudence, medicine, and agriculture; De Seyn-Verhougstraete, whose display is of Flemish literature in general; Havermans, who has fine color-work to show; Hoste, whose specialties are mathematics and music; Larcier, the law librarian; Lebègue & Co., who have choice works in many languages, Latin and Greek, French, Dutch, English, Spanish and Italian, and who also deal in globes, terrestrial and celestial; Mertens, who does fancy work in colors, in the latest styles; Ramlot, who publishes scientific books; the Van Campenhouts, general printers and publishers; Vander Anvers, who exhibits fine work in lithography, and specimens of all kinds of printing in various languages; Vanderpoorten, who publishes music books and various other works; Weissenbruch, a general bookseller; and Zech & Son, an old established house, printing missals in Flemish, French, Spanish, and Portuguese, also Spanish and Portuguese classics.

Outside of this favored circle are several other exhibitors. The Universal Review of Mines and Metallurgy publish their interesting collection; Vaillant-Carmanne has scientific and other periodicals, and a large assortment of general literature; Vanderghinste & Co. and also Bertrand have fine exhibits in the department of music printing; and Bergerhoff van Sassem makes a specialty of works on baking and pastry.

OTHER COUNTRIES.

Switzerland has fine exhibits of decorative painting, engraving, and lithography, as well as books. The Cantonal School of Industrial Arts at Geneva publishes a course of study, illustrated by specimens of work done by pupils, indicating a high degree of culture. Academic drawing and painting, sculpture both in stone and wood, repoussé work in bronze and gold, ceramics and decorative art in general, from the programme of studies. Colliond, of Berne, has a very curious collection of writings in cipher, for diplomatic dispatches, etc. Clo, of Sion, publishes the "Alpine Lyre," and Sin-noutre, of Basel, also publishes works on stringed instruments, as to both theory and practice. Alpine scenery and the general love of

the picturesque that it inspires furnish themes for engravings and chromos displayed by several other exhibitors.

Brazil furnishes abundant State Reports on various subjects, the most interesting, perhaps, being that concerning the meteorite already spoken of in Class 8. Alves & Co., Leuzinger & Son, and Lambaerto & Co. are general book dealers. The "Galeria Ilustrada" is a fine pictorial newspaper. The meteorological bulletins taken at the Imperial Observatory at Rio de Janeiro are of interest to those who seek to reduce meteorology to an exact science.

Mexico displays cheap school books and also works of a higher class, not only in Spanish, but in English, French, and other languages. The printing interest follows the railroads, which are opening up the vast resources of this wealthy region.

The Argentine Republic has eight exhibitors in this class, publishing books, periodicals, and pamphlets in a creditable style.

The Austrian Empire has been content to send a few calendars and *cartes de visite*.

Bolivia is better represented. Her books relate chiefly to her own concerns, her geography and laws, and the biography of her recent presidents.

Chili has some specimens of typography from Santiago.

Denmark has some fine lithographs and engravings, published by seven different firms. Three other exhibitors display books and general printing.

The Republic of San Domingo has two exhibits of books and printing.

Spain is very well represented in this class. Forty-one of her publishers have come to the front, presenting a fine array of elegant works in general literature, science, and music. Two among them display the material of the printing office.

Greece is also very creditably represented. Thirty-six exhibitors, many of whom publish newspapers, are here to indicate the superiority of the national literature. Those interested in the study of modern Greek may find ample means for its successful prosecution in the books and papers before them. Music and engraving also figure among the Greek publications.

Guatemala has nine exhibitors dealing in general literature and matters of national interest.

Hawaii furnishes volumes of a periodical and some printing of tolerable style, interesting as illustrating the march of civilization.

Italy, land of song, has some cases of musical productions. There is also a beautiful illustrated work on the Basilica of St. Mark, at Venice, which may enable us to understand Ruskin. Two newspapers appear also in her exhibit, and some excellent collection of books, some of them elegantly illustrated. An album of antique ornaments and characters is particularly attractive.

Japan sends some specimens of stenography.

Heintze, of the Grand Duchy of Luxembourg, exhibits several fine illustrated works.

From the Principality of Monaco come a treatise on the coins and medals of the country and some official State publications.

Norway has nine exhibitors of the popular literature of the country, as well as some State publications and music.

Holland deals largely in color printing and chromolithography. There is some interesting Javanese work in this exhibit, and also general literature.

Portugal has four publishers, exhibiting books, journals, and proofs, and from her African Colony come specimens of typography executed by the natives.

Roumania's exhibitors show books, music, illustrated volumes for the young, and specimens of engraving and lithography.

Five of the twelve Russian publishers are music-dealers. Four of the remainder display lithographs. Then there are two newspapers, one of which is illustrated. The remaining publisher exhibits books. Finland has periodicals in Swedish and Finnish, as well as proofs of printing and lithography.

Salvador has an array of thirty-seven publishers, and scientific subjects occupy the greater number of the books. Music is also largely published, and the national code of laws.

Servia's productions have been already noticed in the three preceding classes, consisting, as they do, of schoolbooks.

Uruguay publishes works concerning the geography, history, and botany of the country, with statistics of the Republic. There are also two music-publishers.

Venezuela has some fine specimens of typography and exhibits the current numbers of two newspapers.

Algeria has some examples of printing in Arabic and other languages spoken in North Africa. An ancient volume of the Koran possesses peculiar interest. There are also lithographs, works in French on Algeria, itineraries, etc.

Cochin-China gets credit for a treatise on ceramics and New Caledonia for two volumes on the penal settlement, with a map of the Colony; also, a treatise on the sugar cane and another on reform in the army.

Reunion exhibits an excellent dissertation on hurricanes and several works on the production of the island, such as the sago-palm. There is also a display of lithographs.

Senegal is credited with a volume of which it is the subject, with maps.

Some works in Annamite and Chinese, with a history of Annam, appear in the pavilion of Annam-Tonkin and there are some proofs of printing and lithography in the Tunisian pavilion.

CLASS 10.—STATIONERY, BOOKBINDING, AND ARTICLES USED IN PAINTING AND DRAWING.

The article "Bookbinding" takes us back again over the publishers' exhibits noticed in Class 9. Magnificent as are the *éditions de luxe* exhibited, we can not say that they are more splendid than those of old times, when no amount of gold or jewels was deemed too precious to give outward expression to the reverence due to a sacred volume, or even to the esteem in which a favorite author might be held. It is true there are more well-bound books now in the world than ever before; but then a well-bound book will last for centuries, and we therefore have not only those we make now, but also those of former ages. The present Exposition shows bindings in many different materials, in as high an order of finish as popular taste demands or wealth can buy. The variety of material used is a prominent feature in modern bookbinding. We find bindings in wood, inlaid, in mosaics, with darker or lighter woods, jet, or mother-of-pearl. Richly embossed and gilded leather still holds its place among the most desirable forms of binding. Velvet, with metallic bands, corners, and clasps, the precious metals being freely used, is appropriated chiefly to works of devotion. Silk is used chiefly on the inside of the covers. Cloth bindings are cheap, but serviceable in careful hands. They are made very ornamental, especially for gift books and works of transient interest. Rubber makes a very popular binding, and enables the book to be rolled up and carried in the pocket. All these styles of binding are to be found in the American, English, French, Belgian, and other publishers' exhibits.

There is a very fine effect produced by gilding edges that have previously received a crimson tint. This was shown to me in the British section. As the light falls at different angles on the edges, gorgeous hues of red and gold appear in alternation.

Every year some new vegetable fiber is found to be serviceable in the manufacture of paper; in short, it seems impossible to say what it may not be made out of eventually. The manufacture of good and fine paper is still on the advance, both in quantity and quality. Samples of the finest made are displayed in most of the industrial sections, particularly in the American and French.

Neither the perfect ink nor the perfect inkstand has yet been invented, they say. It is well that there is something left for genius to accomplish. An ink that will preserve its color under any and all circumstances, and neither get muddy nor dry up in the inkstand, is still to be desired. Meanwhile, we have exhibits of all that science and art can do at present toward achieving perfection. There are not only black, but blue, red, and many other colored inks; sympathetic inks, which only become visible under certain conditions;

marking inks, for clothing, which do not produce "iron mold;" copying inks—inks, in short, for all the known purposes of civilization.

Inkstands, also, in various shapes, are to be seen; classic inkstands, for literary people; mathematical inkstands, for scientific people; picturesque inkstands, for the tribe of artists; solid inkstands, for financiers; hermetically sealed inkstands, for tourists and news reporters; inkstands that will not upset or allow the ink to dry, for very careless people, and so on.

Pens manifold, also chiefly metallic, in gold, silver, platinum, nickel, and steel; besides the old-fashioned, never-to-be-superseded goosequill. Pens with straight points, oblique points, stub points, and no points at all. Fountain pens, the pen and inkstand combined, to the detriment of each. Pens for forming German engrossing alphabets and all sorts of fancy work. All of these are to be found in the various industrial sections of America, France, and other literary lands.

Among particular exhibits in the American section we may mention the rubber stamps of Baumgarten & Son, of Washington, where stamps of all kinds are needed; the paper of the Greylock Paper Mills, and that shown by Warren & Co. (both from Massachusetts); the gold pens and pencil cases of Fairchild & Co., medalists of several previous expositions, and whose merchandise belongs as well to Class 37, "Jewelry," as to this. Then there is mucilage and liquid glue exhibited by several firms, viz, Carter, Dinsmore & Co., of Boston; S. S. Stafford, of New York, and Underwood & Co., of the same place. All of these have writing, copying, indelible, and safety inks. W. E. Morgan, of Chicago, shows inks for various uses, with bronze powders and illuminating materials. Story & Fox, of Buffalo, have varnishes and finishing for lithographs, and several other notions. Waterman & Co., of New York, make a specialty of "fountain pens," and Weeks & Campbell, of the same place, deal in advertising specialties in leather and celluloid.

France has a long array of stationers and others exhibiting goods belonging to this class. Abadie & Co., and also Cawley & Henry, exhibit cigarette papers, a branch of industry that has developed wonderfully of late years. Mme. Aussedat has some choice papers for engraving and other purposes, including the celebrated paper to which the name "Japan" has been given. Blanchet Brothers & Kleber have photographic and filigree paper, as well as the kinds used for writing and drawing, in various delicate tints and shades. They are medalists of several expositions. Bloch has copying machines and other devices for purposes connected with writing. Bourgeois deals in fine colors in water and oil, both for industrial and artistic purposes; with color boxes, palettes, etc. His China ink compares favorably with that shown by the Chinese themselves.

Chouanard shows cardboard for paper-work, water-tight and highly finished. Dagron & Co. have a fine display of inks of all kinds and colors. Darblay & Son show an equally varied assortment of writing paper. Forest-Vincent & Son exhibit sealing wax and mucilage in great variety, and also inks. François makes a specialty of ink-stands, and shows a pocket inkstand warranted not to spill. Gilbert & Co. deal in crayons and pencils of all colors and for all purposes. Haro Brothers restore and preserve paintings. Mary & Son deal in colors and apparatus for all kinds of painting and drawing. Pitet furnishes paint brushes and pencils to the artist. These and other exhibitors to the total number of two hundred and eighteen, cover the whole ground of stationery and artists' supplies, and provide goods of the most excellent description.

The British section is not behind in commodities of this description, although we do not see our old friends, Windsor & Newton, who supply so many American artists with water colors. Gillott & Sons are still making their steel pens, rivaled by Mitchell & Alexandre. Tetley has machines for the automatic display and preservation of manuscripts, etchings, engravings, etc., which seems very effective in its operations.

Belgium has a large business in the stationery trade, and has long been celebrated for her bookbinding. She exhibits impermeable and wear-resisting cardboards, paper for all purposes and of all kinds, inks, colors, rubber stamps, etc.

Switzerland has seven exhibitors in various departments of the stationery trade; paper, inks, slates, crayons, etc.

Brazil has also seven exhibitors in this class, who show blank books, ruled and bound, artists' colors, and inks.

The Argentine Republic has some fine specimens of binding, and two exhibits of inks.

The Austrian Empire has a finer exhibit here than in the preceding classes. We find paper of all kinds (cigarette paper included), rubber stamps, penholders, and other appurtenances to the writing-desk.

Chili has some specimens of binding and writing materials, and China exhibits the same old "India ink" that has been in use for thousands of years.

Denmark exhibits a copying-press and some specimens of binding.

Spain has a very full display. We notice her playing-cards are somewhat different from those in use in America, France, and England. Besides these, she has artists' colors, cardboard designs, ink, and all kinds of paper, shown by fourteen exhibitors.

Greece has nine exhibitors in this class, who display bindings, writing materials, and artists' supplies.

Italy has some fine *papier-maché* work (chiefly boxes and cases), with drawing, printing, card, and bank-note paper.

The Japanese papers, as we know, can be used as *serviettes*, the qualities of toughness and fineness combined rendering them unapproachable. There is a fine display of different kinds in the Japanese section (plain and colored) manufactured into lanterns, etc. Then we find ivory paper-cutters and delicate penholders and other articles in lacquer, very ornamental as well as useful on the writing-table. Japan has eighteen exhibitors in this class.

Lamort, of the Grand Duchy of Luxembourg, the medalist of previous expositions, has a fine show of tinted and plain papers, etc.

Two bookbinders have exhibits in the Norway section.

Holland has ten exhibitors in this class, whose stationery is all of the solid Dutch pattern. A good deal of straw paper is shown.

Two Portuguese exhibitors display paper, and there are some specimens of native work in bookbinding from the Portuguese colony at Congo.

Roumania shows ink of various colors and bound blank books.

Russia shows crayons, paper, and copying-presses. She has five exhibitors in this class, while her province of Finland has six, who furnish various specimens of paper and cards.

Mexico has also some very curious paper made from native material; the "century plant," as we call it, is put to a great variety of uses.

Salvador exhibits some specimens of bookbinding very creditable to that young and growing republic.

Venezuela has some bookbinding and envelopes.

Algeria shows ink made from native plants. It is very good ink. There is also paper made from material found in the country, and an instrument for geometric drawing, besides some samples of bookbinding.

From Cochin-China we have material for water-coloring, and from Senegal an inkstand.

Annam-Tonkin exhibits the yellow paper stamped with dragons on which civil engineers receive their diplomas. Then there is an Annamite writing-desk, pencil-cases, and paper.

Cambodia displays the peculiar "satra" or writing-paper in use there. We may say in conclusion that the display in Class 10 is very full and satisfactory.

CLASS 11.—ORDINARY APPLICATIONS OF THE ARTS OF DRAWING AND MODELING.

As the extraordinary applications of the same arts are referred to Group I, it might seem at first that this class is designed simply to take in the refuse of the Art Group. Such, however, is not exactly the state of the case. In the Art Group there is but one thing aimed at—the expression of the beautiful. The Apollo and Venus of antique sculpture are simple attempts to represent the human form in

its perfection. In the many-armed Hindoo divinities, hideous as they are, we nevertheless see an effort to express superhuman power,—something beyond mere mortal perfection. They are evidently intended as symbols, not as portraits. They belong to the domain of metaphysics. So, also, in the Department of Coins and Medals, although collections of such articles are usually made to while away idle hours, yet light has been thrown upon history by means of them; and the science of numismatics is by no means to be despised. What we know concerning the wide Empire of the Parthians has been mostly gleaned from their coins. Even the clumsy fetiches of savage tribes have their ethnological value, so that this class is, after all, more nearly connected with education than with art, and is rightly placed here.

The most extensive exhibit in this class is that made by the *Chambre Syndicale de la Gravure* of Paris, a society of twenty-nine exhibitors, who show the most exquisite work in the more delicate processes of engraving. Cameo-cutting, engraving on various articles of jewelry, fine work upon gold and silver, ivory-carving, and the charming effects produced by engraving on mother-of-pearl are here displayed in rich profusion. Even the coarser materials, steel and wood, are ennobled by the artistic processes which they are made to subserve. Work in ceramics is also found in this extensive exhibit, and those who make engraving a study may pass many profitable hours among these interesting and instructive articles. The ancients were, perhaps, as perfect in these arts as we are ourselves, but they kept their processes so well concealed, having no patent system to protect their rights, that it is no small merit to have rediscovered them. Chinese engraving on ivory and mother-of-pearl has, however, never been a “lost art,” but has been perpetuated through the centuries.

The names of Bouasse-Lebel and Massin have been known for at least half a century, not only throughout France, but wherever, in the habitable world, the gospel imagery has made its way. Many a savage, unable to read, has called to mind the teachings of the missionary, by means of the crucifix, the medal, or the little colored print left in his hands or fastened against the mud wall of his hut in place of the obscene figure of the banished fetich. Many a blank and cheerless garret, whose weary occupants keep soul and body together by a life of endless toil, has for its only decoration one of these little tablets from which the benign features of the Madonna or the Guardian Angel smile a promise of happier days to come, and hold in check the evil temptation to forget present miseries amid the delusions of attractive vice.

In every department of this class French exhibits are abundant. Durand reproduces ancient statuary, and his works in marble and

terra-cotta render it doubtful whether he has not crossed the line that divides this class from Group I.

Desmarest caters to the pride of ancestry. He deals in armorial bearings, painted as well as engraved, and the gorgeous escutcheons and crests of the old nobility are paraded before us. Beautifully engraved seals are here, putting us in mind of the days before adhesive envelopes were invented, when a large bunch of seals was a necessary appendage to every watch-chain. Engraving on gold and jewels is a specialty. Stamped and crested letter paper also forms a part of the display, with rings and trinkets of every description.

Engelmann has imitation of stained glass. His genuine glass belongs to Class 19. But these diaphanous paintings produce a similar effect at a less cost. His method of staining glass itself, and the ingenious process of hyalochromy, perhaps belongs here, and are worth the attention of those interested in decorative art.

Fleuret is one of the numerous engravers of medals, and has received many appropriate decorations for his skill in producing them.

Hautecoeur and many others show engravings, etchings, chromos, etc., of the highest order of merit.

Jeandraut has a pretty exhibit of engravings in cork. Thrones and tabernacles and other elaborate architectural details are modeled in this light and destructible material.

Libert shows tapestries and wall papers, with patterns for the same, in which we are glad to note the return to a healthier taste compared with that which prevailed 10 years ago.

Miss Montcharmont has an elegant display of illuminated manuscripts, gorgeous with gold and silver, vermillion, and ultramarine, in the antique style.

Other specialties are the panoramic views exhibited by Poilpot, the advertising cards of Wachter, and the paintings of Miss Zilhardt. There are in all two hundred and twenty-two French exhibitors in this class, embracing a great variety of work in all departments.

UNITED STATES.

The American exhibits in this class are few, but choice, and cover a good deal of ground, Morgan, of Chicago, even devoting himself to heraldic devices, unmindful of the sentiment of him who described his family arms as "My father's shirt sleeves, when he fought at Bunker Hill." Heraldry is interesting only in its connection with history, and the pioneers of our western wilds have at least as noble a place in history as the robber-knights of old, but their armor was not of the same clumsy material. Let them found their claims to nobility on the true records of past struggles, not on the affected arrogance of an effete foreign aristocracy. We do not disparage Morgan's excellent display, but we regret that a demand for it should have crept as far west as Chicago.

As to Maillard's chocolate Venus we do not know what to say. Venus is presumably sweet in any form, but in chocolate she may be thought too sweet for any use. At the time of writing, however, she shows the result of various nibblings, although the Exposition is not half over.

The sculptured marbles exhibited by Caroline S. Brooks take us back from advertising dodges to the realm of the ideal. The beauty of the material and the excellence of the execution are alike worthy of praise, and ought to be sufficient to entitle this exhibit to a place in the Art Group.

The exhibit of the Baldwin and Gleason Company, is also extremely interesting, if only as illustrating one of the various uses to which celluloid has been recently applied. The engravings have, as will be noticed, an interest of their own.

The Coöperative Building Plan Association, of New York, show two fine volumes of excellent building designs, with all the modern improvements.

Dashiel sends some creditable drawings of steam engines.

The reduced form of the splendid Lick medallion is exhibited by Edwards, the modeler of the original.

Harris's designs for cabinet furniture show the results of ages gone before, in the culture of a perfect taste, which is always consistent with the useful purpose for which each article of furniture is required.

We have also some fine lithographic vignettes exhibited by Rath, of New York.

BELGIUM.

The Belgians claim the honor of having made the first serious attempts in the art of photolithography. "Serious" is perhaps a very convenient adjective for the occasion.

The Society of Graphic Art exhibits engravings on wood, zinc, and copper. Goffart, and also Falk, make similar exhibits. The Belgian engravings and lithographs are in the highest style of execution.

Decorative paneling is a prominent feature in this class. Bass shows painted panels for ceiling, etc.; Bandewyns, panels for carriages; Boch Brothers have beautiful panels in faience. A splendid panel of sixteenth century work is exhibited by De Munter. Heins has executed the panel work on the interior façade of the Belgian section. Jaulet has also done some of the painting on this façade. Meunier shows panels in Japanese style, and Launeau has a beautiful specimen of work in this department. Panels painted in imitation of the various kinds of marbles are exhibited by the Fine Arts Institute and by Guelton, and graining in imitation of various kinds of wood is found in Logelain's exhibit.

De la Montagne, a medalist of previous expositions, displays some

rich imitations of Gobelin's tapestry. Van Cauwelaert makes a similar display, and has also received decorations.

Splendid designs for all kinds of interior decoration are exhibited by Desaucourt. Furniture, mantel-pieces, lusters, work in iron, gold, and jewels form some of the numerous details of his display. He also has patterns for lace-work, which are a specialty with Despiegler, Naten, and others.

Besides these there are numerous exhibits of tickets, calendars, and blanks of all kinds in great variety. The Belgian display is very full in this class and worthy of careful study.

GREAT BRITAIN AND HER COLONIES.

The British exhibit in this class is of a very practical character, bank notes, checks, scrip certificates, postage-stamps, etc., figuring in it largely. Advertising-tablets are shown, and patent enamel letters, both in copper and iron, as befits a "nation of shopkeepers."

In the pavilion of British India we find a nearer approach to the ideal. Here we find carving and inlaid work; but most of it must be considered as belonging to some among the classes of Group III.

SWITZERLAND.

Wood-carving is the Swiss specialty in this class, and the exhibit is wonderfully varied and remarkable. Two schools devoted to this art, besides several private exhibitors, have displayed their proficiency. Here we find book-cases, work-tables, clocks, picture-frames in various styles, brackets, and chairs. Animals, fruits, and even flowers are faithfully represented in these carvings, and a portrait is shown burnt in upon the wood.

Homberg, of Berne, shows some fine graving work on watch-cases, medals, and in other forms.

Orell, Füssli & Co., of Zurich, show legal blanks and forms and some fine portraits.

BRAZIL.

Three exhibitors from Rio Janeiro show lithographs and chromos. A lady from Maranhas, Mme. de Freitas, exhibits a beautiful imitation of engraving in silk embroidery. The Viscountess of Cavalcanti displays a very complete collection of Brazilian coins and medals, and Texeira has an equally perfect exhibit of postage-stamps. A model of a machine for printing in colors is referred to this class, as also is the panorama of the city and bay of Rio Janeiro.

OTHER COUNTRIES.

From the Argentine Republic we have a specimen of pen drawing, and from Austria some wood engraving.

Bolivia has three very fine collections of coins and medals.

Chili exhibits seals, medals, and some plaques.

Denmark has seven exhibitors, showing fine imitations of Florentine mosaics, imitations also of marble pillars and Gobelin tapestry; but what is of more interest than any imitations, however ingenious, is the decorative painting of ancient Danish architecture exhibited by Bund, of Copenhagen. A stuccoed ceiling displayed by Berg is also a work of considerable merit.

A statue of Christopher Columbus exhibited by the Dominican Republic is said to be an exact copy, in diminished proportions, of that erected at San Domingo. The likeness of the great discoverer has, until late years, been a matter of doubt. The present statue follows the best accredited type. The Republic also shows carved spoons and engravings of various degrees of merit.

Ecuador exhibits antiquities of the aborigines and paintings on textile fabrics.

Spain has some fine exhibits. The heraldry of Lazaro has an historical value, as also has the archæological exhibit of the Artistic Society of Barcelona. Framed engravings are also sent from the same city, and some fine penwork comes from Madrid and Tolosa. The School of Art at Ferrol sends handsome paintings on various substances.

The Grecian exhibit is confined to wood-carvings.

Guatemala sends wax fruits, carved calabashes, Indian antiquities, including some valuable gold images, wood-carving, and calligraphy.

The paintings on silk furnished by nine different Japanese exhibitors have all the rich and quaint fancies, with the harmonious coloring that we were accustomed to expect from that interesting empire. This, however, forms but a small item in the exhibit from Japan referred to this class. Oil paintings are shown by two other exhibitors, and a third displays work in water colors. The minister of agriculture and commerce makes a very full display of ingenious Japanese work in bronze, enamel, lacquer, ivory, wood, faience, iron, and silver, including vases, censers, boxes, plates, panels, tables, etc. A model of one of the gates of the temple of Nikko interests us not only by its artistic merit, but also for ethnological and historical reasons.

Monaco has an elegant assortment of coins, jewelry, and seals.

Norway also exhibits medals and some fine engravings of old Norwegian country houses and the national fauna.

From Holland a great variety is furnished by a small number of exhibitors. Classic models are followed in much of the work. There are chromolithographs, mural decorations, and imitations of woods and marbles.

Portugal has several magnificent engravings, painting on faience,

basso-relievos, and pen sketches. A collection of coins current in the Portuguese colonies is larger than might be expected.

Roumania has nine exhibitors in this class, whose work includes a great variety both as to subject and material. There is a lithograph on satin of the King and Queen, several other lithographs, pictures on cherry-bark, silk, etc. A great deal of penwork is shown, and some pretty flower painting.

Russia sends some industrial designs, and her province of Finland a collection of coins, with chromos representing the fish and birds' eggs of the Grand Duchy.

The Government of San Marino sends decorative panels giving different views of the city and citadel; with plaster casts of the state seals.

From Salvador come elegant and fragrant carvings upon cedar wood. The national coat of arms is carved on this material. Then there are different coins, choice lithographs, and models in plaster of fruit and flowers, with other specimens of national ingenuity.

Uruguay sends her national escutcheon.

Venezuela furnishes some terra-cotta idols and a tripod, taken from an Indian burial-ground.

Algeria shows a Roman coin of Micipsa and some late modern work in the shape of imitation marble, carved wooden frames, industrial drawings, and stamps.

Cochin-China, French India, Annam-Tonkin and Cambodia give us a whole Pantheon of Oriental divinities, statues and images of Buddha being of the most frequent occurrence. Buddha is said to number one-third of mankind among his followers, and his cast of countenance, as he is represented in different lands, is so faithful to a fixed type that we may well believe it to be a likeness handed down by constant tradition. Whether he is considered a mere man who has attained superhuman privileges by abnegation and contemplation, or whether he is represented as the eternal creator of all things, as he seems to be in Japan, in his character of Amida, he has always the same features—the same unruffled placidity of countenance. The large ears are perhaps symbolical of his readiness to hear his suppliants, but why should his eyes be so narrow, and have that sly expression inconsistent with European notions of rectitude? He comes in all sizes and in every material that can be graven or molten. The theology of the Brahmins also furnishes a long list of gods, with several heads and arms, each hand bearing some symbol of power. The infant Krishna, on his serpent couch, puts his foot in his mouth, perhaps as a symbol of infinity conveyed by an ordinary infantine gesture. Other gods attended by their wives and retinue, inflict chastisement on giants and monstrous beasts. Besides these idols, there are paintings on silk from India, bronze bells from Tonkin, and coins from Cambodia.

Tunis sends Arabic caligraphy and antiquities such as have been already noticed in previous classes.

The clumsy idols sent from Tahiti, Gaboon, Congo, and Senegal give us an idea of the first efforts of the savage to mark his sense of a superhuman power. They are as far below the Indian figures in symbolism as they are below the classic models in symmetry and beauty. Their carving was the occupation of indolence and their worship the homage of superstitious fear. Congo has also some carved elephants' tusks, and Senegal shows the furniture and pottery of western Africa.

Reunion shows some pretty paperweights and some portfolios of drawings. Also, a picture formed of moss and lichens, and the head of a stag carved in wood.

New Caledonia displays coins and native curiosities, with some hair work. Mayotte also shows a specimen of native handicraft.

Martinique exhibits hair work, drawings and paintings in oil and water color. Guadeloupe also has water colors representing Caribbean antiquities, an album of native fruits, and a collection of coins.

CLASS 13.—*MUSICAL INSTRUMENTS.*

Simple as seems the title of this class, it contains many incongruities. Besides the magnificent church organs, the brilliant pianos, the silver-tongued flutes, the magic violins which afford genuine music, we have here to consider the barbarous instruments by which savage tribes render hideous the splendors of a tropical night, and which can only be interesting from an ethnological point of view. Worse yet than these there are, even in civilized lands, those who like their music to be performed for them by the aid of machinery. If they like it so, let them have it by all means. It is not the intention of the writer to disparage any of the musical machines in the Exposition. They are probably good of their kind, and it is noticed that there is always a little crowd of admirers about them when they play. But the crowd of admirers is probably recruited from those who visit the Exposition once, perhaps, during the whole summer. To those whose occupation and duty oblige them to a daily attendance the musical machines are not precisely a boon; and even occasional visitors who have been charmed for a few moments with the rich, deep tones and harmonies of an organ, or the sparkling roulades of a piano, are shocked at having their dream of bliss disturbed by the sudden dissonance of the machines. The mistake was not precisely in exhibiting these machines, which are acceptable, no doubt, to a numerous class, but in giving them such a position as to spoil the effect of genuine music.

In the manufacture of organs great progress has been made of late years. Manufacturers, instead of following out the old routine, have

traveled, studying and making comparisons in Germany, England, and France, and hence have advanced towards perfection by uniting in a single instrument all the best elements they have met with in their travels.

This eclecticism has been the more judicious, as the two great schools of organ building, the German and the French, have special artistic qualities, contrasting in character. The German school, for example, has always faithfully preserved the traditional solemnity of the organ, cultivating the richer and sweeter stops—the bourdon and the flute—which are the more characteristic organ tones; while the French taste inclines to the more brilliant and accentuated reed-stops—the trumpet, hautboy, clarinet, and *vox humana*.

A certain amount of tact was necessary to combine these elements homogeneously; for, while endowing the instrument with stops of a lighter character which, by their wild and strangely sympathetic notes, would produce a stirring effect on the audience, it would not do to lose sight of the traditional gravity of the organ, which adapts it rather to religious than to worldly uses.

The cause, then, of the great progress in organ building of which we have spoken lies in the manifestation of this exquisite tact, this power of successful combination of contrasting, if not conflicting, elements. Especially in France has this success of late years become unequivocal. France at present possesses organ builders of superior eminence in their profession.

Although expression has been the principal aim in these improvements, the mechanical part has not been neglected. Many mechanical difficulties, a few years ago deemed insurmountable, have been coped with quite successfully by recent enterprise. Among these difficulties may be named the abundant and regular supply of wind to the larger pipes of 8, 16, and 32 feet, and the effecting of lightness of touch by rapidity of transmission from the keyboard to the sound-board.

Barker's pneumatic lever was designed to be a powerful auxiliary to the organ builder, but some at first considered it too complicated, others too costly, which retarded its general use. But now it is found everywhere, and some large organs have three, four, and even five pneumatic motors.

The organ bellows itself has undergone changes. As the reed-stops were made more powerful and numerous, as the basses were augmented, and as the pneumatic machine was introduced, it was found necessary to divide the wind supply under different pressures; hence we have large reservoirs of air which vastly increase the power of modern organs.

The mechanism, however, of musical instruments, whether considered in the manufacture or in the subsequent use made of them, can never of itself bring them to perfection. The delicate instincts

of genius, working by ear and hand, can alone give the finishing touches required for true excellence. The human heart can never be reached by mere machinery, and to appeal to the heart is the aim of all genuine music.

In string instruments, particularly in violins, there has also been some improvement of late years. For a long period, despair of excelling or even of equaling the Cremona violins of a century and a half ago had damped the energy of manufacturers. The secret appeared to have perished with the great Italian masters; but recently violins of sweeter, richer tone have been produced, and it is not impossible that a return to antique excellence may again be effected.

FRANCE.

As the transportation of the larger musical instruments is expensive, we should naturally expect that home talent would take the lead in this exhibit, and accordingly we find more musical instruments displayed by France than by all other nations together.

E. & J. Abbey, of Versailles, exhibit a fine organ designed especially for a tropical climate. They have also plans of the splendid organ now building for the Church of St. Severinus. They show a special form of the pneumatic lever patented by themselves.

Cavaillé-Coll exhibits a splendid organ in the style of Louis Seize for use in a concert hall. He has also a model of the organ of St. Peter's at Rome, reduced to one-tenth of the original. He has supplied several Parisian churches, as well as the Trocadero, with their justly-celebrated organs.

The organ society of the Alexandres make it a specialty to supply organs at cheap rates so as to bring organ music within the reach of poor congregations. An organ at 100 francs (a little over \$19 of our money) is manufactured by them. They have a steam factory at Ivry, and supply organs and harmoniums to order for churches, schools, and public halls. They have received numerous medals at former expositions and the cross of the Legion of Honor.

Harmoniums of various kinds and degrees of excellence are exhibited by the well-known house of Rodolphe. Their great organ harmonium has twenty-one and a half stops, two keyboards, besides pedals and couples.

Thibouville-Lamy, Richard & Co., Mustel, Mayer-Marix, Dumont & Lelièvre, Cottins & Tailleur, Christophe & Etienne, and others, exhibit harmoniums in great variety. Merklin & Co. show a peculiarly contrived keyboard, and use the electro-pneumatic transmission.

The chief favorite among modern musical instruments (the piano) has, as might be expected, its place in numerous exhibits. First among all, holding still the high place it has occupied for half a century, stands the house of Erard & Co., whose world-wide fame will

receive no appreciable increase from this notice. Medals and prizes from all expositions, except where the proprietor has himself served upon juries and hence declined competition, attest the merit of the Erard piano. They come in all forms—grand, square, upright, and cottage pianos—and their excellence is too well known to need more than a passing allusion.

Besides Erard, there are fifty other exhibitors of pianos among the French, each of whom claims some special perfection for his own instruments. These claims, perhaps, are all well founded, for what constitutes perfection in a piano is very much a question of individual taste, and matters of taste are proverbially beyond discussion.

There are also many exhibitors who make specialties of the different parts of the piano—the strings, the hammers, the keyboard, etc. Some have mechanical contrivances by which the piano and organ may be made serviceable to those who have never learned to play upon them. Music for dancing, especially, can be furnished by this means.

The flute is an instrument which French manufacturers have succeeded in bringing to great perfection. The clarinet, piccolo, fife, and all wind instruments of which wood is the principal material, are usually its companions in the same exhibit. The old-established house of Herouard Brothers, at present represented by Laubé, displays all these instruments in great variety. They are without rivals in sweetness and power of expression. The Thibouvilles also deal largely in flutes in addition to other musical instruments of every description.

Violins, violas, and violincellos are also very numerous represented. Paquette Brothers have some fine instruments for quartets, and Jacquot & Son have also a grand display on the old Italian models. They are the medalists of the First Universal Exposition, that of London in 1851, and of several subsequent World's Fairs, having kept up a world-wide reputation for half a century. Eugene Henry has also an old-established house for the same class of instruments, and we might add the name of several others.

Instruments for band music, in brass and other metals, also appear to be abundantly represented. The General Association of Work-people has a display in this department. Berson, who has received several decorations during the past 10 years, has a very extensive exhibit, and is the author of a system that bears his name.

Other instruments, such as guitars, mandolines, saxhorns, and harps are also exhibited. One exhibitor shows the old-fashioned harp-sichord. Others confine their display to violin strings and bows and other accessories. France has altogether one hundred and fifty-three exhibitors in this class.

SWITZERLAND.

The Swiss exhibit is next to the French in number of exhibitors, it is to be regretted, however, that automatic musical boxes form so large a part of the show. These were always a Swiss specialty, and their tinkling melodies are more agreeable to the ear than the brazen tongued mechanisms alluded to in the preamble. Not that Switzerland is confined to these, by any means. Rordorf & Co., of Zürich, display pianos in every style, whose excellence has met with general recognition. Trost & Co., of the same place, also exhibit pianos, as also does Baiger. Wahlen deals in flutes, with a simplified system of fingering. Siebenhuner has violins, violas, and violincellos for his specialty. Wolff deals in various musical instruments. Then then there are exhibitors of piano stools, wood for musical purposes, and other material, the whole number being eighteen.

BELGIUM.

The Belgian exhibit is of considerable importance. Pianos are exhibited by Camps & Co., successors to the old-established house of Berden & Co., and also by Hainant & Son, and by Heinemann, the latter following the style of Louis Seize. Renson & Son, whose merit has been acknowledged at previous expositions, also show some fine pianos. Bells are a feature in the Belgian section. Fine mellow chimes in bronze are displayed by Van Aerschodt, and they are excellent specimens of the bellfounder's art. Violins and violincellos are exhibited by Mongenot and also by Pierrard, both of whom are medalists of previous expositions. Brass instruments are displayed by Mahillon and by Van Cauwelaert, hautboys, flutes, and clarinets by the Alberts, and clavichords by Dietz. The Belgian instruments seem to be up to the average of the best made in any country.

ITALY.

The history of music is so connected with Italian imagery that we are surprised that this home of the muses has taken no higher place in the Exposition. Whether they have not cared to compete, or whether music is really on the decline there, is not evident. What has been sent reaches a high standard of excellence, as would naturally be expected. Two exhibitors show pianos, and there are some violins; but the peculiarity of the exhibit consists in little known instruments, such as the dyophone, so called from its emitting two notes at the same time of different quality but of the same tone, like two voices singing in unison. There are also musical instruments in terra cotta, to which the name of "ocarines" has been given; and there is a highly ornamented mandoline.

THE UNITED STATES OF AMERICA.

We have only three exhibits in Class 13. The labor and expense of transporting heavy instruments across the ocean, is perhaps, one cause of this. Weber—a name which can not be pronounced without exciting musical ideas—Weber, of New York, sends four of his excellent pianos to compete with European manufacturers, we may hope successfully, although upon their own ground. Dion provides an equal number of violins, with a bridge perfected by himself. Bohmann, of Chicago, sends violins also, with guitars and zithers. Small as the United States exhibit is, we may congratulate ourselves that it represents genuine music in the highest sense of the word.

GREAT BRITAIN.

From London come two exhibits of pianos, the iron-framed instruments of Bishop & Sons, who have a patent on stoneware insulators; and the more varied display of Brinsmead & Sons, who show a piano divested of its case, with models of inventions and patent improvements. There are three exhibitors of violins, who seem to attribute a great deal of importance to the varnish. Silvani & Smith have brass instruments, handsomely plated with silver, and also flutes and clarinets. Then we come down to concertinas, orchestrinas, and other devices for disturbing a quiet neighborhood.

OTHER COUNTRIES.

Spain, of course, makes a specialty of her guitar, the most romantic of all instruments, and the one that appeals to the æsthetic faculty through the sense of sight as well as that of hearing. Besides, there are two exhibits of pianos from Barcelona, and music books, which should have been referred to Class 9.

The Austrian Empire has a fine quartet of stringed instruments from Buda Pesth, violins and cellos from Prague, and brass instruments from Königgrätz, in Bohemia. Vienna sends mouth organs.

Greece has five exhibits of instrumental music.

Guatemala shows a guitar composed of 6,114 pieces of wood. The writer has not counted them, but is content to take the exhibitor's word for it. There are two other exhibits of musical instruments, and several specimens of musical composition, among which is the national hymn of Guatemala.

Portugal sends a piano, some flutes, and other instruments. Band instruments form a feature in her exhibit.

Two pianos come from Holland.

The Russian exhibit in this class is comparatively full. Krall & Seidler, who received a distinction at our own Centennial in 1876, and other decorations at Vienna and Paris, send concert pianos from their house at Warsaw. Malecki, and also Kerntopf & Son, whose

establishments are likewise in the ancient Polish capital, have concert pianos on exhibition. Glavatch, of St. Petersburg, has pianos and harmoniums. Flutes, violins, etc., are shown by other houses.

Servia has seven exhibitors of instrumental music.

Norway sends pianos from Christiana, and violins from other localities.

Salvador has four exhibitors of stringed instruments.

The Dominican Republic sends a guitar and other instruments.

Chili sends violin strings, and the Argentine Republic a guitar.

Brazil has an interesting collection of guitars of various kinds, mandoras, mandolines, violins, and other instruments. There are two "*violons sourds*" for beginners. Would that every beginner practiced on a "*violon sourd*."

And now comes a long list of nations whose ideas of music are different from those that prevail in Europe and America. The gongs and bells made in Cambodia and Annam, have, it is true, a marvelously sweet tone, and the secret of its production has not made its way yet into the west. There are also piano cases manufactured from wood indigenous to Gaboon Congo, for which that colony gets credit; a curious piano symphonium, producing the effect of a quartet of stringed instruments, comes from Algeria, and Reunion sends some violins, but with these exceptions the exhibits from the French colonies are mere curiosities, producing no tones that we can call musical. The same may be said of the Portuguese colonies, as well as of the Republics of Bolivia and South Africa and of the Kingdom of Hawaii. The merits of the stringed instruments sent from Japan are more open to question. Japanese ideas of melody are different from ours.

CLASS 14.—MEDICINE AND SURGERY.—VETERINARY AND COMPARATIVE MEDICINE.

The most remarkable attention is shown to the exhibits in this class by nonprofessionals. Even the musical instruments of Class 13 attracts smaller crowds. In the room where the various forms of disease are represented in wax effigies, particularly, there is always a crush, rendering it difficult to effect a passage. It is plain from the gestures of the gaping, tittering crowd that it is no scientific interest, but simply a morbid appetite to gloat over misery, that attracts them, the same depraved propensity that used to draw such throngs to witness a public execution in those bygone days when criminals were made to serve the purpose of a warning to those whose instincts propelled them towards vicious courses. For, valuable as these elaborate representations of disease may be to those who make the cure of disease a special study, those not engaged in the medical profession can see nothing in them but provocation to horror and disgust. Here are the various pustules that characterize

the different fevers and skin diseases accurately colored, so that measles may be readily distinguished from scarlet fever, and either from nettle rash or erysipelas. Here, too, are the frightful effects of cancer portrayed with shocking fidelity—faces, eyes, tongues, breasts, eaten away by ulcer. The interior of the human frame is laid open, and diseased hearts, kidneys, livers, and stomachs are displayed to view. Such is the spectacle that fascinates the mob. Would it not have been better to have reserved these things for medical students, who would look upon them with a different eye? The same fascination does not seem to draw spectators to the cases of surgical instruments, artificial limbs, bandages, and other appliances. Those who inspect these do so, evidently, with a critical eye, appreciating merit where it appears, and perhaps forming notions of still further improvement.

The science of medicine continues to show a wonderful vitality. Its developments, even during the last ten years, continually open new fields of activity. Microscopic research has been its chief employment lately, and discussion still seems to be open as to the value of the results obtained. Meanwhile, Pasteur's well-known experiments, and the new science of bacteriology, have necessitated the manufacture of various new surgical instruments, in particular those used for antiseptic purposes.

FRANCE.

Of all the nations that have sent surgical instruments here, the French have made the most brilliant and complete display. On entering the rooms from the southeast the well-furnished cases of Mr. Matthieu at once meet the eye. On the right artificial limbs, chiefly arms and legs, with carefully articulated feet and hands, are displayed. The mechanism of these is wonderful, as well as the combination of lightness with strength, which appears upon closer examination. A young man, by the aid of one of these artificial legs, actually dances, executing without fatigue or embarrassment all the complicated steps of the waltz, mazourka or schottisch. Art nowadays, seems to supply all the nonvital parts of the human frame. In the left-hand case of Mr. Matthieu's exhibit we see a brilliant array of metallic instruments, mostly nickel-plated, although steel is used wherever freedom from rust can not be secured in a baser metal. Among these are several newly-invented instruments for use in obstetrics, antiseptic appliances already mentioned, and improved forms of instruments long in use. A new sound, for exploring and expanding the urinary passages, seems to unite firmness with flexibility in a surprising manner. There are also a new set of scoops, a new saw for use on the bones, and several instruments to be used in diseases peculiar to the female sex. It is interesting to note that among various forms of pincers the American

seems to be given the preference. Dental instruments are continually rendered nearer to perfection. A new and very handy form of the tourniquet may also be seen in this exhibit.

Pradel & Paquignon make a specialty of supplying family medicines, a work of doubtful utility, for families, like individuals easily become addicted to valetudinarianism, and a passion for dosing once awakened is a demon difficult of exorcism. The family *malade imaginaire* does not restrict his experiments to his own person, but administers pills and powders to his unfortunate offspring as often as any ache or pain comes beneath his notice. Let us hope that the remedies furnished by Pradel & Paquignon are at least harmless, which, in regard to drugs, however, means much the same as ineffective.

Robillard furnishes artificial eyes, which will move naturally, and do anything almost except see. They are inserted without any surgical operation, and the resemblance is claimed to be perfect.

Wickham shows trusses for hernia, and cushioned bandages for various surgical purposes.

Voitellier has apparatus (*convenses*) for the rearing of children born before their time, with thermosiphon attachment. Also artificial incubators for fowl, etc. The exhibit extends to all details for raising and fattening poultry, for the care of dogs, etc.

Saudras exhibits inhalators and antiseptic apparatus for the organs of respiration.

Talrich makes a fine display of anatomical models in hardened wax. The models exhibit both the healthy and the diseased condition of the various organs of the body.

Le Gonidec has an assortment of various elastic trusses and bandages used in surgery, including the stocking for varicose veins, orthopedic apparatus, etc.

Martin supplies cheek to those deficient in that article, also artificial noses that can be worn without the spectacle attachment. The imitation of the skin in color and texture appears very perfect.

Osselin is one of those who still find believers in electric belts, magnetic hair-pins, galvanic bracelets, and other such delusions. He has a patent on electro-magnetic finger-rings.

Genesto, Herscher & Co. exhibit disinfecting apparatus for beds and bedding, garments, rags, surgical instruments, spittoons used by consumptive patients, hospitals, barracks, stables, slaughter-houses, etc. Their exhibit is to be found in a special pavilion on the Esplanade des Invalides.

Friese makes the teeth a specialty. He has false teeth in various styles and all the articles used by dentists, including a plastic enamel of his own invention.

Froger has a great variety of lints and other material for stanching blood, antiseptic and otherwise.

Gauttard provides paper and gold-beater's skin for the same purpose and for the healing of wounds, burns, and stings.

Dutheil supplies chairs and carriages for the sick and weak in great variety, adjustable at any angle, contrived so that the invalid can wheel himself about or change his position with very slight exertion.

Dumez has special bathing apparatus, with a system of syringes.

Choquart & Penchot provide ophthalmoscopes, laryngoscopes, mirrors for dentists, and other instruments for pathological examination.

The anatomical models of Dr. Anzoux exhibiting the parts not only of the human frame, but also of animal and vegetable organisms, have long been appreciated in the Parisian schools of medicine and of pharmacy, anthropological and other museums, veterinary schools, and public institutions of every kind, and seem well to deserve their celebrity.

Carne's system of gymnastics, contrived with a special view to the recovery and preservation of health, has been duly appreciated at several former expositions.

Yvon & Berlioz show some new instruments used in bacteriology.

In all, there are one hundred and thirty-four French exhibitors in this class, most of them Parisians, and the display made by them includes all the most recent contrivances for rendering more endurable the woes of bodily infirmity.

BELGIUM.

The Belgian exhibit comes next to the French in completeness, although the number of exhibitors is far smaller. Great credit is due to the medical fraternity of this little but enterprising nation for the part they have taken in experimental research during the last ten years. Van Ermengen has made a special study of the Asiatic cholera microbe, and Henrijean, Firket, Francotto, and others have given important assistance to throw light on the new-born science of bacteriology.

Dr. Plettinck-Bauchau shows a special method of setting a broken arm, with the splints, bandages, etc., to be used for various parts of that useful member, including the humerus, the elbow-joint, and the forearm.

Dr. Felix shows a treatment for fractures of the thigh and another for deformities of the thorax. Also metallic appliances for stanching wounds, tin foil, etc.

Dr. Soupert exhibits plaster models, showing various methods of amputation, and also a series of surgical treatises.

Medical and surgical works form quite a feature in the Belgian exhibit. They are displayed by Drs. Van den Corput, Thiriar, Spehl, Kuborn, Du Moulin, Delannois, De Keersmacker, Debaisieux, and

Crocq, while the Medico-Surgical Society of Liege exhibits its annals.

The exhibit of the medical flora of Belgium, including cultivated as well as indigenous plants, is also very interesting.

Dr. Hovent's respiratory apparatus is worthy of careful study, embracing, as it does, the application of newly-discovered principles.

Wasseige has a complete exhibit of surgical apparatus for midwifery.

An operating-table shown by Davies-Glibert appears to have several special advantages which make it a desideratum.

Delattre has an anatomical study of the human head.

Taken in its entirety the Belgian exhibit covers the principal subjects in medicine and surgery, and appears up to the requirements of the age in which we live.

UNITED STATES OF AMERICA.

The exhibit in Class 14 from the United States is small, but represents several different fields of usefulness. Frees' case of artificial limbs is the most prominent feature to the cursory observer. They are equal to anything of the kind produced in any country.

Rhodes, of Chicago, exhibits audiphones, enabling the deaf to hear by means of the teeth. Where deafness, as is often the case, is caused by obstructions in the external ear, this method of reaching the auditory nerve is eminently useful.

Lena M. Hoffman, of Philadelphia, has an excellent form of gynecological chairs.

Seabury & Johnson have a complete assortment of plasters, antiseptic dressings, absorbents, splints, and surgical specialties, highly creditable in every way to the well-established reputation of the firm.

Fell shows an ingenious respiratory apparatus.

Piper, Doremus & Co. have an extensive exhibit in the department of rubber goods, syringes, etc.

The Pomeroy Truss Company exhibit a contrivance to be used for the support of the spine. Cleopatra K. Farrington has also a patent spinal supporter made of hard rubber, without springs, and designated as "The Obelisk."

Schott has a fine array of antiseptic instruments.

Roy has cauterizing apparatus for veterinary purposes as well as for the human subject, and a set of gum surgical instruments.

Nicholson exhibits artificial ear drums.

Knapp has a set of vaporizers for the vaporization and subsequent inhalation of medicines, a new system of doubtful value.

There are two exhibits of dentists' work, one by Brown, of New York, and another by Farley, showing crown, bar, and bridge work, with a grinning array of artificial teeth.

OTHER COUNTRIES.

The British have but a small exhibit in this class. The artificial limbs are mere models in reduced size. Gray & Son, who have an establishment in New York as well as in Sheffield, show trusses and enemas, and also electrical and magnetic apparatus.

The Swiss regard their school benches as belonging to this class, since they suppose them to afford support to the spine. Their merit, however, is not beyond question. They have, besides, a tolerably complete exhibit in those articles more particularly belonging to this place. There are two dentists, Dr. Wienaud and Dr. Schlenker. The latter's exhibit is quite exhaustive, and deals with the whole interior of the mouth, both in its normal and abnormal conditions, including a speaking machine of the exhibitor's own invention. Professor Reverdin, of Geneva, exhibits surgical instruments originated by himself. An apparatus for the removal of the wounded in a mountainous country is of special interest, as characteristic of the national needs. Then there are anatomical preparations, apparatus for the direct transfusion of blood, artificial eyes, trusses, antiseptic instruments, bandages, and appliances for stanching blood, etc.

Brazil has two exhibitors in dentistry, and one who has invented an instrument for the chemical analysis of urine.

Mexico displays some anatomical preparations and ingenious models in gum elastic of various parts of the system.

The Austrian Empire has only two exhibits in this class, a case of instruments for the vocal organs from Buda-Pesth, and a general display of surgical apparatus from Cracow.

Bolivia sends some aboriginal skulls of ethnological rather than surgical interest.

Chili has an exhibit of artificial teeth, and also a collection of instruments used in vaccination.

Spain has two exhibits in dentistry, two in orthopedic apparatus, one of general pharmaceuticals, and some respiratory appliances.

Greece has three exhibits in dentistry and one of methods of vaccination.

Stoerner, of Christiana, Norway, exhibits the Norwegian inhalator, his own invention.

Roumania has some artificial limbs, trusses, and an anatomical preparation of the human ear.

Russia is among the many nations that make dentistry a prominent feature, three out of her six exhibitors dealing in artificial teeth. Civilization seems to produce a ruinous effect on the means of mastication supplied by nature, which are found in their best perfection as attachments to the savage skull. The other three exhibits are of saws for dissecting purposes, pulse registry, and pharmaceutical capsules.

Algeria determines the age of the calf and ox by examination of the teeth from three months up to twenty years. She has also a water cure, and some orthopedic apparatus.

CLASS 15.—SCIENTIFIC INSTRUMENTS.

The exhibit in this class is very complete, and embraces a vast number of newly-invented instruments; for invention must keep pace with the rapid strides that science is yearly and daily making. No very large telescopes, of course, can be placed on exposition, for the labor of removing and shipping an observatory instrument is no slight matter, to say nothing of the loss to science which its even temporary removal would involve; for those who watch the heavens continually find new surprises for us. The perfection, however, to which portable instruments now have been brought is matter for scientific congratulation. A telescope which with its tripod can easily be carried from the house to the garden, is sufficiently powerful to reveal the wonders of astronomical science to the delighted gaze of youth. The rings and some, at least, of the satellites of Saturn, the disks of Uranus and Neptune, the double stars with their beautiful contrasts of color, and the prominent nebulae, are sufficient to convey elementary notions of the charming science to the learner, and they can all be seen through a portable telescope.

FRANCE.

On entering the French section the eye is immediately attracted by the large meridian circle lately constructed by Mr. Gautier. The object glass is $8\frac{1}{2}$ inches in diameter. Mr. Gautier has constructed observatory instruments for Paris and several other important astronomical posts, not only in France but also in Algeria, Austria, Spain, and South America. The present instrument has been ordered by the Argentine Republic, and will be used in the observatory at La Plata.

The Society of Opticians have a very complete display of instruments. Many of them, the spectacles and opera-glasses for instance, belong more properly to Class 19, being scarcely "instruments of precision." The magic lanterns, also, belong, as "instructive and scientific toys," to Class 40. There remain, however, terrestrial and astronomical telescopes, microscopes in various forms, some entirely novel, spectroscopes and prisms, and all the array of surveying and engineering instruments. These are the compass, mounted in various shapes, the theodolite, repeating singly or doubly, the level in all its forms, for the builder as well as the engineer, the alidade, the pantagraph and the various scales, linear and trigonometrical. All of these are capable of perfect adjustment and are perfectly graduated, precision in this respect being every year more easily effected. The same

may be said of the marine instruments, sextants, mariner's compasses, and plummets. Besides these the opticians show barometers in various shapes, including the aneroid, the alcometer, the areometer, the gleucœnometer, the densimeter, and other instruments for testing the density of sirups, liquors, acids, etc. Thermometers also appear in great variety, for medical use, for baths and apartments, with hygrometer attachments and thermometrographs. An instrument of less precision, the pedometer or step-recorder, is also shown. There are also pneumatic, electric, and magnetic machines, which belong less properly to this class.

Messrs. Richards Brothers have a most interesting class of instruments for measuring and recording the velocity and direction of the wind. One of them is in actual electric communication with the top of the Eiffel tower, nearly 1,000 feet above the location of the instrument, and it is very interesting to watch the index silently tracing on the paper cylinder its perpetual record of the currents of the upper air. The conditions of temperature and moisture in the atmosphere also form part of the record. The inspection of an instrument such as this prompts the thought that perhaps some day, probably when we are very old, we may at least know something definite about the weather.

Verick & Stiassnie show some very neat instruments for micrography, comprising microscopes, microtomes, and apparatus for microphotography. The developing science of bacteriology has called for several new forms in these instruments.

Madame Prince has some finely graduated rules for taking linear measurements, both according to the metric and to foreign systems of measure. These are made in every material, boxwood, ivory, silk ribbon, and metallic tape.

Perteers & Son, successors to Naudet & Co., exhibit aneroid barometers in the holosteric form for taking levels, and for marine and meteorological purposes.

Nachet's microscopes have long been favorably known, and their merits have been recognized at several previous expositions. He has now improved them with a special view to their usefulness in bacteriological investigations.

The minister of public works displays the instruments used in the practice of civil engineering as conducted by the French Government. It is needless to say that they include all the improved forms known to be of practical advantage. The bridges and pavements of Paris alone are triumphs of the engineering profession, and give sufficient evidence both of the mathematical accuracy of the instruments employed in constructing them and of the brains and culture of those in whose hands these instruments have been placed.

Bardou exhibits some fine astronomical telescopes; also telescopes fitted with micrometer wires to measure distances. These are mounted

and fitted up in various ways to suit the purposes for which they are designed.

Secretan, successor to the old-established firm of Lerebours & Secretan, also furnishes astronomical and other telescopes of a high order of excellence.

Mignot makes manometers and vacuum indicators a specialty.

Chateau & Son exhibit rain gauges, strephoscopes, and chronometers.

Vesly has a rule for gauging casks, barrels, etc.

Of the numerous French exhibitors in this class some that we find catalogued here confine themselves to the display of lenses, spectacle glass, etc., which properly belong to Class 19. Of those which are truly "instruments of precision," we may say that every effort has been made to meet the more and more exacting demands of science. Absolute mathematical accuracy will never be attained by the use of even the finest-grained material substances; but we may go on making nearer approximations without any known limit.

THE UNITED STATES OF AMERICA.

The United States exhibit, although nothing like so full as the condition of the sciences in that country would lead us to expect, has several interesting features. In looking over the list we find that none of our great instrument makers are here—none of those whose names are inscribed on the transits and levels in use on railroad and other surveys. New York, which has given us the "Gregg level," sends absolutely nothing but an addition machine, whose patentees have assumed the venomous, not to say Satanic, name of "The Adder Company."

The system of electric time signals furnished by the United States Observatory is perhaps the most interesting exhibit in this class that has been sent across the Atlantic.

The Signal Service has also sent the meteorological instruments in actual use—the triple self-register, wind vane, anemometer, rain gauge, etc.; also a fine mountain barometer with double vernier and Tuck cistern.

From the Department of Agriculture comes a new combination freezing microtome, the invention of Dr. Thomas Taylor, microscopist to the Department; also a pocket polariscope for the detection of imitation butter. Both of these instruments give evidence of inventive tact and ability to meet the wants of the age.

Darling, Brown & Sharpe send rules, T-squares, gauges, and measuring instruments in general, concerning which we may say that they are finely graduated and will give all the accuracy that can be communicated to a pencil point.

Mary A. Booth's microscopical preparations are also very creditable to her skill, patience, and judgment in making selections.

Dion shows an echophone, with apparatus registering the vibrations of the human voice.

Hollerith proposes to take the next census by electricity—the favorite agency of this century.

It will be seen that our exhibits in this class are of rather striking originality. The writer must decline to regard spectacles and glove fitters as instruments of precision.

SWITZERLAND.

The Swiss instruments have a deservedly high reputation which they have retained for many years, and they are still keeping up to the requirement of the age.

Kern & Co. continue the manufacture of the celebrated mathematical instruments known as “Swiss compasses,” and exhibit several specimens, with the latest improvements. Also, instruments for surveying and astronomical purposes, pantagraphs, stadia, tachygraphometers, theodolites, and planimeters.

The Genevese Society for the construction of instruments of precision show equatorial and meridian telescopes, spectroscopes, microscopes, air pumps, and apparatus for measurement in great variety.

Usteri-Reinacher has barometers in various forms, hygrometers, rain gauges, thermographs, and similar instruments.

Amsler-Laffon & Son show instruments for nautical purposes, hydrometric apparatus, rheometers, etc., of fine construction and careful gradation.

Klingelfuss shows a neat builder’s level.

Despres makes a specialty of the sliding-scale, divided on the metric and other systems.

Chatelain has an ingenious form of the podometer and other mathematical instruments.

Coradi shows the integrator made by himself, on the Abdank-Abakanowicz system. This instrument delineates the integral curve from the tracing of the differential. He has also planimeters, pantagraphs, and instruments for geodesy.

Other exhibitors, the total number being eleven, combine with these to give us a very satisfactory idea of Swiss skill and ingenuity in the province of mathematical instrument making.

BELGIUM.

The Belgian instruments are distinguished by delicacy of make and accuracy of form and subdivisions.

Gerard & Co., of Liège, have a very perfect assortment of instruments of precision, physical and electrical apparatus, medical and physiological instruments, theodolites and levels for geodesy. They make a specialty of apparatus for the measurement of electricity,

galvanometers, rheometers, the autodyagrammatic apparatus of Professor Kennedy, etc.

Colonel Hannot shows the tacheometer, and instrument devised for the rapid execution of topographical work.

Wery, of Liège, has some excellent mathematical, as well as physical, instruments, vernier compasses, surveying instruments in general, compasses of reduction, by which very minute subdivision may be effected. He undertakes to make any instrument according to the drawing or model furnished.

Rosso makes optical instruments his specialty. He has ophthalmoscopes, optometers, barometers, thermometers, telescopes both for terrestrial and astronomical purposes, microscopes, etc. He has been decorated for his services to science at several previous expositions.

It is noteworthy that three out of the six Belgian exhibits come from Liège. The third is Jaspar, who exhibits an excellent chronograph in the form known as "Le Boulange." He has also received decorations.

Beaupied, of Brussels, shows a pair of elliptical compasses.

Limited as is the display of philosophical instruments in the Belgian section, it is sufficient to show the care and fidelity exercised in their manufacture. In no department of this group do the national characteristics manifest themselves to such advantage.

GREAT BRITAIN.

The new acoustic instruments invented and patented by Rein & Son form the most strikingly original feature of the British exhibit in this class. Deafness is among the most trying of the infirmities that afflict old age. The "closing of the doors," as it is affectingly called, is a trial not only to the person whose ears have failed to fulfill their office, but also to all who attend upon him and seek to give him aid and comfort. But these acoustic instruments will reopen the closed doors, and make life again a blessing.

Telescopes and microscopes are shown by several exhibitors. Clarkson makes astronomical instruments a leading feature, and in particular has a fine altazimuth with slow motions and object glasses 3 and 4 inches in diameter. He also shows surveying instruments.

Pillischer also has surveying and meteorological instruments, but he makes more of a specialty of the microscope. He exhibits also the ophthalmoscope and some very accurately divided mathematical instruments.

Ross & Co. have a novel construction for varying power in telescopes, also microscopes and accessories.

Dallmeyer likewise deals in microscopes and astronomical instruments.

The characteristics of the British exhibit are accuracy and solidity. Delicacy must sometimes be sacrificed to solidity, especially in surveying instruments, which must be able to resist wear and tear, and where a line is to be marked out with stakes, it is useless to attempt more precision than a stake can mark.

OTHER COUNTRIES.

Russia's exhibit is comparatively full and varied. We find here the different forms of balance, including a special contrivance for weighing coin; rheometers, for the measurement of the velocity both of water and wind; rain gauges and wind registers; a polarimeter for beet-root sugar; a contrivance for delineating curves, and physical and mechanical apparatus in general. Finland furnishes a limnigraph, or tide gauge.

Italy sends some chemical balances and mathematical instruments, but her lenses and spectacle glasses belong to Class 19.

The Austrian Empire exhibits balances also, and some microscopes, etc.

Spain sends chronometers and levels and some philosophical apparatus.

Denmark has two exhibitors of mathematical instruments, and an apparatus for hydrographic work.

Holland deals chiefly in very precise balances. She also sends some meteorological and philosophical instruments.

Servia's display is chiefly of instruments used in military engineering, particularly in the founding of cannon.

Portugal has some rules and other mathematical instruments.

Salvador shows some forms of the Roman steelyard.

Greece sends thermometers.

Norway exhibits balances and the orograph, by which various measurements may be made.

Japan has some rulers and squares made of bamboo.

The Dominican Republic furnishes an inelastic cord.

Brazil shows a new azimuth telescope, invented by the former director of the Rio Observatory.

The Argentine Republic exhibits balances for coin and chemicals.

Algeria displays a tacheometer, giving the ratio of the slope to the horizontal distance without calculation. Also, a combination by which a walking-cane is made to act as a rule, a square, a plumb-line, and a level. There are, besides, Roman steelyards, balances of other forms, chronometers, and other instruments.

Annam-Tonkin furnishes balances and Annamite measures.

Two of the French colonies, Mayotte and New Caledonia, are likewise credited with balances. The latter has also a podometer in the form of a walking-cane.

CLASS 16.—GEOGRAPHICAL AND COSMOGRAPHICAL MAPS AND APPARATUS.

TOPOGRAPHY.

There seems to be an unlimited quantity of topography on exhibition, principally by the French, some of it excellent and some of it very slovenly. On the wall of the northeast portico of the Trocadero are to be found topographical plans and profiles of the estate of St. Hermine, in La Vendée, which would be disgraceful even if exhibited as school work. The Director of the Exposition ought not to have accepted them at all. As topography is an ordinary application of the art of drawing, much of it has been already noticed under Class 11. Other specimens, again, have come under Class 9 as school work. There still remains, however, enough beyond ordinary work to deserve notice in a class by itself.

FRANCE.

In the French exhibit the first place is probably due to the great globe of Villard & Cotard, which occupies a pavilion, and excites considerable interest. It is often loosely spoken of as being in size the millionth part of the earth, the fact being that its circumference and every line drawn upon it is the millionth part of the same line on the earth, but as spheres are to one another as the cubes of their circumferences, it would take 1,000,000,000,000,000,000 such globes to equal the earth in bulk. Even on this large globe the flattening at the earth's poles is only 21 millimetres, a fraction imperceptible to the observer.

The globe turns on its axis, and observers use a spiral staircase to view it from north to south. It is so large that the perspective effect in distorting the shape of the continent is quite remarkable.

The oceans, seas, lakes, and rivers are painted blue, the tint varying in depth with the depth of the water. The land is painted of an olive-green tint, no political divisions being allowed to confuse the eye with various colors, but dotted lines indicate the national limits. The mountains are not in relief, their elevation, if made according to scale being too slight to catch the eye. They are indicated by the usual topographical shading. The names of cities are placed against the points which indicate their location. There is room for many more without crowding the map. Volcanoes are represented by red spots, railroads by red lines, and telegraphs are traced in gold.

Different colors indicate the lines of ocean steamship travel. The English lines are blue, the French red. Let us hope that there was no childish spite in assigning black to the Germans. The Italian lines are green, the American violet, the Austrians orange, the Rus-

sians white, the Spanish and Portuguese combined yellow and red, and the Swedish, Norwegian, and Danish, white and green.

Regions of metallic wealth are indicated as follows: Coal by black spots, copper by blue, iron by red, silver by white metallic spots, gold by gilded ones, and diamonds by a diamond-shaped steel spot. All these colors, however, do not cover enough space to mar the pleasant harmonious contrast of light blue and olive green which characterizes the globe as a whole. At the poles a whitish coloring indicates the average extent of floating ice there.

A drawing in cross section in the same building shows, on the same scale, the probable thickness of the earth's crust, the proportionate height of mountains, the depths of the various oceans and seas, and the approximate height of the atmosphere. Other charts furnish statistics concerning the population and principal productions of various countries.

The delineation of the various coast lines, rivers, lakes, mountain chains, etc., on this globe has evidently been a work of great care and patience. The vast rivers in the interior of Africa are shown according to the data furnished by the latest explorers; but after all, we must regard it as a work rather curious than useful. A student could hardly have it at hand for purposes of consultation. It serves however, to show how thoroughly we have made ourselves acquainted with the world we now inhabit. There is no room for any future Gulliver to locate supposed discoveries. Even Rider Haggard works in shackles. How much wider a field for his imagination would he not have had in the reign of Queen Anne?

Plans and topographical charts of the city of Paris are very plentiful, and have been made for various purposes—as simple maps for reference, as exhibits of the water supply, as showing the sewerage (subterranean Paris is a city in itself), as exhibiting the state of education (the schools and their districts being made specially prominent), as showing the parts most subject to epidemic, where we have one map for measles, another for scarlet fever, another for smallpox, and so on, the infected localities being marked by spots on the general tracing of the streets. Most interesting are the plans which show the historical growth of the city. There is Paris of 1649, of 1789, and of 1889. It is interesting to note that the development has been mainly westward. The Ile de la Cité was once the center of the city and the Place de la Concorde was near the western boundary. Then the Tuileries became the center, and finally the Place de la Concorde itself is at least the center of activity. The old *faubourgs* or suburbs are now all within the walls. The estates of Clichy and Monceau are shown as they were at the time of the revolution—country places with no more houses than would accommodate the farmer and his laborers. They are now integral parts of Paris, thickly built over, and seething with population. Bird's-eye views of Paris

are also given at various historical periods, the Bastille forming a leading feature. The increase in the number of bridges is also noteworthy. In one of the maps the Pont de la Concorde, now the most thronged of all the bridges, is the farthest west. There are at the present day no less than six bridges west of the Pont de la Concorde. These maps also throw a light on various subjects that might perplex the present sojourner in Paris. For instance, there is between the bridges of Passy and Grenelle a long, narrow, and perfectly straight embankment called the Allée des Cygnes, or "Swans' Path." It is evident that it is not a natural island, and the tourist amazedly asks: "Why should such an embankment have been made in the middle of the river?" But these maps show an old island, natural in shape, but marshy and unfit for building purposes. They channeled out the course of the river on both sides of this island to make it navigable, and trimmed the island by so doing into its present artificial shape. There are also plans of Paris in relief, showing the valleys of the Seine, the canal, and the Bievre, which divide it into four very unequal parts, and the hills of Montmartre, Mount Parnassus, and Chaumont. The Eiffel Tower is higher than any of these hills, although the Champ de Mars, on which it stands, is low in the river valley.

Other French cities are represented here in plan. Rouen, Amiens, Beauvais, Chartres, Auxerre, with the whole department of the Yonne, to which it belongs, are all mapped out for us. There is a relief plan of the rocky ridges of the Cevennes; also of the river Vanne and its neighborhood, showing how it may afford part of the Parisian water supply. An ideal relief plan represents the Butte Montmartre laid out as a pleasure ground. Many of the departments have furnished maps. The lost provinces of Alsace and Lorraine are fondly cherished in map form. Sometimes they appear added to the map of France with a dark cloud resting upon them. Maps of France are seen on every wall. France in departments, France in provinces, France in climates, France as to its mineral productions, as to its manufactures, as to its commerce, France in every possible shape appears everywhere. Maps of Europe and of the world also figure largely in the French exhibit. Globes, both celestial and terrestrial, are also numerous. A celestial globe of Coronelli's, bearing the date MDCXCIII (1693), is interesting as showing the difference in the constellation figures as recognized in his day. Boötes, whom we now represent in compliance with classical authority as pursuing the Great Bear, is seen walking in the opposite direction. He holds a reaping hook in his hand, instead of the leash of *Canes Venatici*. *Canes Venatici* themselves are not there. Their place is filled by the River Jordan, a constellation unknown to modern astronomy. To each constellation are attached all the names by which it is, or has ever been, popularly known. Some of the more

prominent constellations have a wonderful variety of names, but the familiar name of "Dipper" had never then been applied to the seven stars of the Bear. The stars are not very well located, those forming Orion's belt, for instance, would be unrecognizable as such, were it not for the figure of Orion. The then recently discovered southern constellations are located and named about as we name them.

As to minor topographical work, surveys of estates, plans and profiles of railroads and of other public works, the very best is perhaps equal to the work we do in the United States, and those who have examined the careful delineation of charts furnished by our Coast Survey will know that this is high praise. A great part of the work shown is in what we may call the advertising style, to be found in real estate agencies, where careful attention to lines yields to flashy contrasts of color and fancy lettering. And some, again, as we have already said, is absolutely slovenly. There is so much of this kind of work on exhibition that the French seem to have aimed at quantity rather than quality, hoping that the inferior work might escape observation in the throng.

UNITED STATES OF AMERICA.

The maps furnished by the Department of Agriculture, showing the distribution of mammals and birds of economic importance, are an interesting feature in the United States exhibit, the more so as the indigenous tribes of earth and air are so rapidly passing away. The buffalo, which was thought appropriate to the State seal of Indiana in the early years of this century, is now scarcely to be found on the great plains. The beaver's work, in the form of dams, may yet be traced, but the animal himself is no more than a tradition. The European sparrow is fast driving our native song birds from the neighborhood of human habitations. Like the red man, the mammals and birds must yield to foreign immigrants, and these maps, correct as they may be now, will soon be of historical value only.

The States of Wisconsin, Pennsylvania, and Minnesota have sent geological maps and reports. In the case of Pennsylvania, where the coal industry is such a prominent feature, the exhibit is particularly full and instructive. The State geologist of New Jersey has also sent reports and maps, and from New York we have reports on the Adirondack surveys—another blow to destroy the charm of wildness in that picturesque region.

Our friends, Rand, McNally & Co., are on hand with their maps and atlases, which have been favorably known to us for many years.

Hall, of Albany, New York, and Foote, of Philadelphia, furnish geological maps and surveys.

The international weather charts, furnished by General Greely,

seem to foreshadow dimly the perfectibility of the supposed science of meteorology, which perhaps is destined to rob us of a convenient topic of conversation in the remote future. Climatic charts are also furnished, with charts of severe storms and flags of the service.

Whitehouse sends some valuable Egyptian maps, made from recent surveys, and executed in relief. There are the remains of the ancient canal and the course of the new one.

Excellent as are the United States exhibits in this class, we regret that so few who excel in this kind of work have cared to compete. The labors of the United States Coast Survey, marvels of diligence and skill in execution, are not shown. The Mexican boundary surveys, with all the interesting details of the flora, the fauna, and the anthropological remains of the cave-dwellers and other aborigines, would form a course of study in themselves. Perhaps the time when this survey was made may be considered too far back in the remote past, but the railroad surveys of this interesting region are now continually bringing new matters of interest to light. The topography of a large part of the Rocky Mountain region has been mapped recently by the Denver and Rio Grande and other railroads. No country in the world has done so much topographical work in so short a time, and a far better display might have been made had it been thought worth while.

SWITZERLAND.

The Alps furnish unlimited fields for topography and relief plans. Accordingly we find much of this class of work, both in actual relief and colored so as to give the effect of relief on a flat surface, in the Swiss department. Vast Alpine regions, tinted so as to distinguish the perpetual snow line and the geological characteristics, are displayed on a scale large enough to suggest the reality.

The relief of the Jungfrau, by Simon, of Basle, on a scale of 1 to 100,000, and that by Imfeld, of Mount Rosa and the Lake of the Four Cantons, are especially attractive. The topography, above the snow line, can only be approximate. Not much more than the conspicuous peaks could be taken by triangulation, but then the labor of proving inaccuracy would be excessive and nothing would come of it.

Ringier, of Berne, shows relief plans on a scale of 1 to 50,000.

Heine, of Zurich, has an ideal relief of physical phenomena.

The federal topographic office at Berne shows several specimens of topographical work on scales varying from 1 to 100,000 up to 1 to 25,000. A very full atlas, known as the Siegfried Atlas, contains many pages of lithographic and copper-plate charts and maps in the highest style of execution. There is also a geological atlas of Switzerland containing twenty-five maps on a scale of 1 to 100,000.

Bonthillier de Beaumont has a fine projection of the sphere, with the differences in time noticed at various principal points.

Hofer & Burger have an excellent statistical atlas containing a mass of useful figures for reference, besides other maps and charts.

Wurster, Randegger & Co. furnish a plan of their city of Wintherthur and its environs with sundry other topographical and geological maps and charts.

BELGIUM.

Belgium may justly boast of what she has done in the making of maps and charts. Mercator, the inventor of the projection of the sphere which bears his name, and which is chiefly used in marine charts, was a native of what is now Belgian territory. During the last thirty years the Government of the country has been particularly zealous in the promotion of geographical knowledge. The actual work done by state authority may be classed thus: Hydrographic charts prepared by the marine department, plans and profiles of roads and bridges made by the department of public works, various geological maps, charts of coal beds prepared by the administration of mines, charts prepared by the department of railroads and telegraphs, and, in fine, work executed under the care of provincial or communal boards of administration, particularly the fine mural maps in the Exchange at Antwerp. The activity of the Government has been seconded by private enterprise, and if the natural features of Belgium and the outside world are not sufficiently familiar it has not been the fault of the Belgians themselves.

Van Scherpenzeel-Thim exhibits vertical and horizontal sections of a coal mine at Mons, called "Da Borinage." The horizontal section is taken 300 metres below the level of the sea. Those who know the difficulties attendant on mining engineering will appreciate the care evident in the execution of these maps.

Geological charts are furnished by Malherbe Dewalque and the *Cercle de la Librairie* at Brussels. Geographical maps are also shown by the last-named society and by Van der Wee, Falk, and Captain Henry.

Lebegue exhibits globes, celestial as well as terrestrial, and Adrien shows a cosmographic apparatus designed to exhibit the planetary motions.

Zboinski displays the original drawing of a map of the Lower Congo, maps of Africa and of the Asiatic coal beds, with interesting treatises on the subjects of the maps—a very instructive exhibit.

OTHER COUNTRIES.

All the colonies, French, British, and Portuguese, and several independent states, furnish maps of their respective territories, as a general thing on a large scale, those of the Japanese Empire and the Argentine Republic being particularly fine.

The British exhibitors show maps, globes, and atlases, chiefly for

school use, which might have been noticed under Classes 6, 7, and 8 if they had pretended to any educational exhibit.

The Norwegian exhibit is excellent. This land is now so much frequented by tourists that maps are made for their special benefit, showing all the principal lines of travel. An association of journalists exhibits a chart made with special reference to the display of those spots chiefly enlightened by their own labors. Graphic charts, published by Dietrichson, give statistics relative to fisheries, the iron mines, and other Norwegian interests. Other charts show the legal methods of dividing up land, and there are some fine maps for general purposes.

Holland exhibits maps of her colonial possessions in the East Indies, besides the whole and various parts of her domestic territory. There are also globes, maps of the world, etc.

Greece sends us a plan of Athens, a city whose history will always make it interesting. Also, she furnishes statistics of her present established monarchy, and numerous maps.

Bolivia is very creditably represented. Relief plans of Lake Titicaca and other regions of her varied surface are highly interesting. Mineralogy is an important feature on the charts, indicating as it does possibilities of untold wealth. There is a large general map of the republic, besides maps of her particular localities, and the usual charts.

The Argentine Republic also makes a very complete display. The writer has already mentioned the large relief plan in which the curvature of the earth is taken into consideration, which forms so prominent a feature in the pavilion. Besides this there is an atlas showing the various subdivisions of the Argentine territory. The province of Cordoba furnishes a demographic map and plan. Graphic registers are sent by Entre Rios.

The Algerian maps are particularly instructive, delineating, as they do, territory little known until lately to Europeans, although much of it is classic ground, the scene of the old Numidian wars. The department of Oran is fully represented geologically, agriculturally, and meteorologically. The tourist will also find a pocket railroad guide. Plans of projected water supply and sections of artesian soundings are also shown. A relief plan of Constantine and its environs, made by the pupils of the school there, should have been catalogued under Class 9. Then there is a plan for remodeling the city of Algiers, which will have to cope with many conflicting interests, probably, before it is executed. The maps of the Sahara and of the transsahara region throw a new light on the possibilities of the Great Desert with its many oases. Perhaps, like the Great American Desert, it is destined some day to blossom like the rose.

Brazil has also an instructive display in this class. There is a series of maps which furnish a history of the development of Brazil-

ian resources, beginning with a Portuguese map of the sixteenth century. This is shown in the original handiwork. A Dutch map of the seventeenth century follows. The eighteenth century is represented by a map by Juan de la Cruz y Olmedilla, and the chain is finished by Brazil as it exists at present, shown in an excellent map of Levasseur. There is also a maritime chart of the coast, maps of various provinces, and hydrographic maps of several well-known ports.

Mexico shows atlases of the finest topographical work, being surveys of several of her States and their subdivisions, executed by order of the Government. The vast mineral wealth of the Mexican States will soon be the occasion of many more such surveys.

Uruguay generously maps out her principal gold fields for the use of prospectors. She also shows an interesting vertical section of the mountain at Montevideo, the geological strata having been determined by numerous borings. There is likewise a chart demonstrating the transformation of physical forces, besides meteorological charts.

The Caucasian Mountains, once supposed to be the original home of the white race, form a prominent feature in the Russian exhibit, the peaks that rise above the perpetual snow line being duly colored white, while the portions of the Black and Caspian Seas connected by the chain appear blue. Russia also shows a plan of the city of Kiew, one of its ancient capitals, superseded by Novgorod, Moscow, and St. Petersburg in succession. Finland exhibits charts and statistics.

Portugal's maps chiefly relate to her colonies. There are some plans and working sections of a railroad in Angola, which show that the dark continent is soon destined to have its mysteries unveiled.

Servia catalogues in this class statistical charts which more properly belong to Classes 6, 7, and 8.

Paraguay furnishes charts of her territory and plans of her capital city.

Monaco also displays a plan of her principality in relief, with zoölogic and hydrographic charts.

Luxemburg has a beautiful relief plan of the celebrated Forest of Ardennes, the principal scene of Shakespeare's "As you like it" and of much other romantic literature. She also furnishes a fine topographic map of one of her principal river valleys.

Chili sends railroad maps, geologic, agricultural, industrial, and other charts, and a relief plan of her narrow territory.

Spain offers plans of several of her cities and various maps.

Denmark has only a botanical chart in this class.

Italy has graphic relief plans of various interesting localities; Rome and its vicinity, Sicily, the island of Ischia, etc.

Japan's exhibit is excellent, showing the result of geologic research,

meteorological observations, and tracts subject to earthquakes. There are also plans and sections of existing light-houses and of others in contemplation.

San Marino has a relief plan of the city with its defenses.

The South African Republic furnishes several maps. Other territories have been content to give the topography specially interesting to themselves and the tourists who visit them. Hawaii furnishes a relief map of the mountainous islands of her group. The French colony of Reunion also gives a relief plan.

Annam-Tonkin shows Annamite maps, very creditable to native industry, and representing the two provinces of Sontay and Hanoi, with their principal cities.

A general retrospect on the subject of these classes seems to disclose the fact that a healthy state of intellectual activity is manifested in the exhibits coming from the United States, France, Belgium, Switzerland, San Marino, and Japan, the mental vigor of France showing itself to some extent also in her colonies, particularly Algeria. Other lands once named for brain energy, such as Italy, Greece, Egypt, Spain, Portugal, and China, have relapsed into real or apparent torpor. The luxury which succeeds victory in the struggle for existence seems to have paralyzed national activity; or is it despair of excelling or even of equaling the works of the mighty men of old that remain in these homes of a by-gone civilization? In other countries obstacles seem to have been raised by monarchical governments to prevent competition for prizes offered by a republic celebrating its centennial. Otherwise, how can we account for the apathy manifested in the exhibits from Austria, Russia, Holland, Denmark, Norway and Sweden, and the British Islands and colonies? National animosity alone is not the motive for the entire absence of the German Empire, which is now the most opposed of all governments to the republican form, the very stronghold of modern Cæsarism. The educational group is the one of all others most liable to government influence, and a frown from the throne is sufficient to check zeal for the glorification of a land where the throne has ceased to be imposing. In contrast to this sulky behavior of the old monarchies, we turn with pleasure to the bright awakening of intelligence in the republics of South and Central America, whose tasteful pavilions are among the chief ornaments of the Champ de Mars. Here, too, we must reckon young, constitutional monarchies, such as Brazil, whose enlightened ruler did well to sacrifice his birthright in Portugal for a more promising field of usefulness. Servia and Roumania, rescued from the despotism of the Turk, are showing what liberty will do for mental elevation. Finland even, attached as she still is to a despotic empire, manifests a propensity to make as good use as possible of what freedom she has obtained. In other lands, such as Hawaii,

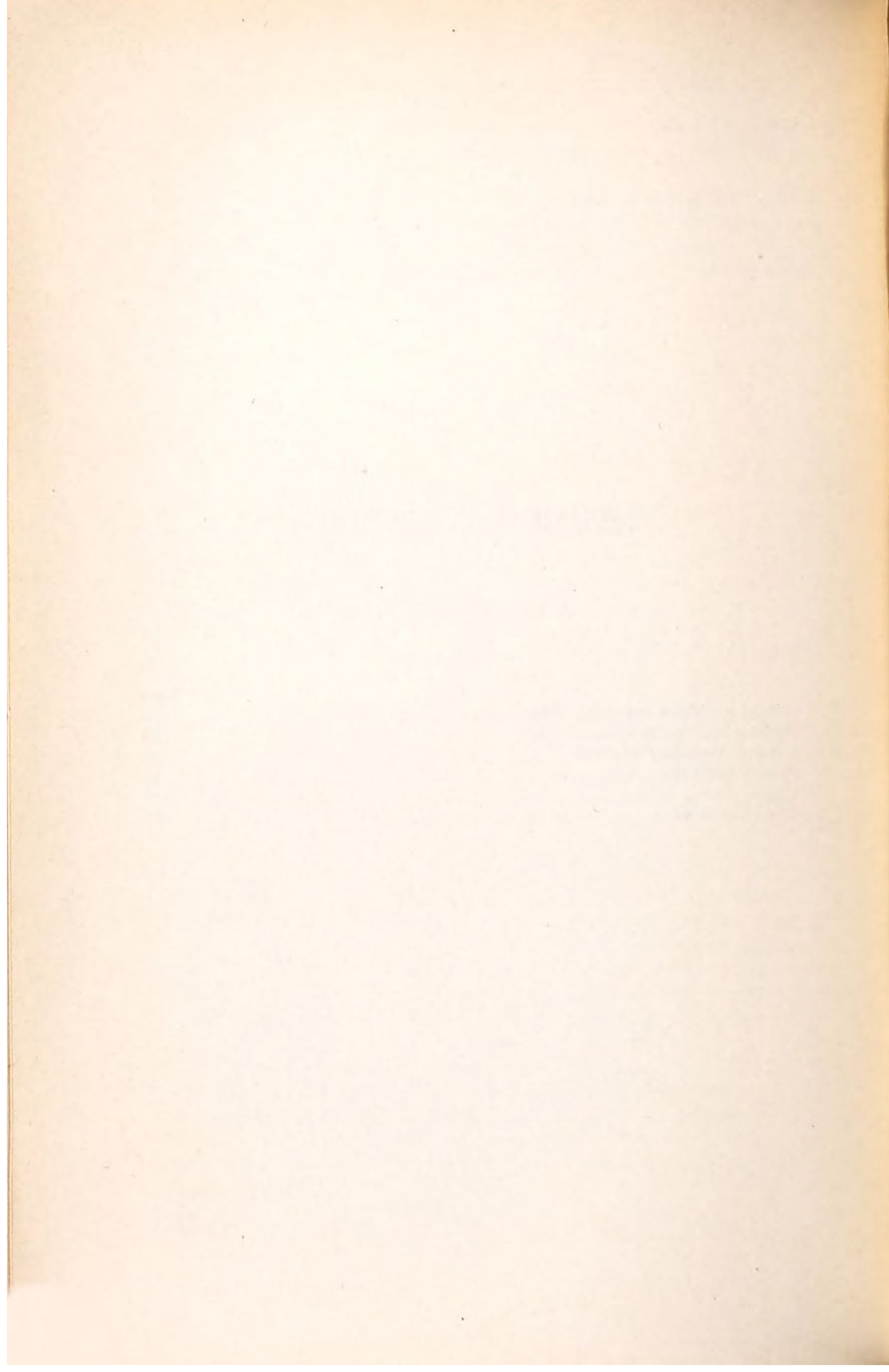
Domingo, and the South African republic, the great awakening is as yet a mere glimmer of the dawn—the blessed prelude, we trust, to a fuller, broader light.

On the whole the prospects for educational interests are decidedly cheering. The concourse of various nations itself at these expositions is a powerful aid to education, dispelling prejudice, diffusing kindly feelings, and continually strengthening the growing sense of universal human brotherhood.

TECHNICAL INSTRUCTION.

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TECHNICAL INSTRUCTION.

BY C. WELLMAN PARKS.

Just before the opening of the Exposition the French created this new class to embrace such exhibits as had previously been shown indifferently in the elementary, secondary, and superior educational classes. This class of instruction has become so prominent in all Europe, and especially in France, within the last few years, that its results constitute the greater part of all that is exhibited in the way of educational products.

The requirement for admission to this class was said to be that the instruction given at the institution should be such as would directly assist the recipient in his future work of providing for himself and family. This would seem to be broad enough to admit all of those schools of France that have been brought under the influence of the law of March 20, 1882, which made manual work an important and obligatory part of the course in every elementary and secondary school of France and colonies.

Although few of the elementary schools were actually catalogued in this class, I nevertheless think this a proper place in which to say something of this movement, and will try to show briefly what has been done in France, with its centralized educational government, in the short space of seven years.

March 20, 1882, the French Parliament passed a law making manual work obligatory in the schools, but neglected to provide the means for introducing and carrying on the work. With some people that would have meant delay, but it meant no such thing with the French, for Mr. J. Ferry, the minister, and Mr. F. Buisson, the superintendent of elementary instruction, at once sought out an able man in whose hands they placed the development of the work. The Exposition of 1889 contained some evidence of the great advance that has been made under the direction of Mr. G. Salices. The first difficulty was due to the lack of teachers rather than to the lack of funds, so the preliminary step was the establishment of a temporary normal school in which to train teachers for the regular normal and superior schools.

At the end of two years this school had prepared seventy-two teach-

ers, who nearly supplied the regular normal schools, so the temporary institution was closed at that time.

The complete course of manual work extends from the kindergarten to the high and professional schools, and consists of work with pencil and drawing-board, paper folding and cutting, clay modeling, wood, iron, and brass turning, carpentry, forging, soldering, brazing, molding, casting, filing, and jointing. Within seven years 649 schools have been supplied with shops and instructors, and a start has been made in 12,000 more.

It should be known that for several years previous to 1882 France had in Paris, in the rue Tournayfort, a model school of this class, which was started in 1870 as a private venture by Mr. Laubier. The object of this class of instruction is to bridge the gulf that has separated the educated engineer from the uneducated workman, and it is believed that this can best be done by early inspiring a love for methodical and scientific labor. The fact is recognized that the greater number of the children who attend the elementary schools will be forced by circumstances to earn their bread, and the time that can be spent in school is so used as to make the child more likely to grow into an able-bodied, broad-minded adult, who will serve the nation efficiently both in times of war and peace.

For facility in giving and acquiring information, no pains and expense are too great for France. Millions of francs have been spent in providing models for drawing classes, and specimens of those things which serve for food, clothing, shelter, and the enjoyment of the people for elementary schools, so that the eye as well as the ear may be made a channel of communication with the pupil.

The Industrial Scholars' Museum is something novel to us, and deserves a word of explanation. It ranges in price from \$12 to \$50, and contains specimens so classified as to show the appearance of the material in the raw state, when partially manufactured, and in the completed commercial article. That of Mr. C. Dorangeon costs \$12, and, in a compact form, it presents 34 specimens of grains, 44 of vegetables and spices, 125 of hemp, cotton, linen, wool, and silk, 55 of leather and skins, 76 of dyeing, 66 of stones and woods, 70 of metals, 68 of heating, ventilating, and lighting, and 59 of things more for enjoyment than necessity.

FRENCH EXHIBITS.

The most prominent of all the exhibits was that made by the Conservatoire des Arts et Métiers of Paris, and the exhibit was well worthy of the institution. It occupied a large part of the central ground-floor space in the Liberal Arts Palace, and consisted of an excellent collection of models of canals, locks, dams, machines, roofs, railways, and other engineering structures. This institution should be copied in this country to a greater extent than it has been. At-

tempts have been made in a few of our cities to carry on some part of its work, either museum or lecture, and the results are not such as to discourage the promoters.

The Central School of Arts and Manufactures made a display of work which would indicate the benefits derived by living in close contact with the Conservatoire des Arts et Métiers. As a school for mechanical engineers and manufacturers it must be given first rank.

With a polytechnic in Washington in close relations with the National Museum and Patent Office Museum, we should have a nearly parallel institution, and one that should be able to do as good work.

The National Schools of Mines and of Bridges and Roads made excellent displays of documents and models, as did also the National Schools of Arts and Trades at Aix, Angers, and Chalons-sur-Marne.

The full size specimens of wrenches, hand-vises, link-motions, universal joints, and even larger machines, as lathes, steam-hammers, shaping and drilling machines, and a compound engine, show that the work done in these schools is of high grade, and that as a substitute for the old apprentice system they may be found efficient. If the work is now found to be good, it seems as though the introduction of manual labor into the elementary schools must tend to make it still better, for the pupils will already have acquired some knowledge of materials and tools when they enter upon the work of the technical schools. In addition to the specimens of work from the machine-shops were those to show the range of instruction given in bronze and iron casting, forging, stair, tower, and roof construction, and the use and care of steam and hydraulic plants, boilers, pumps, engines, and turbines.

The National Apprentice School of Dellys, Algeria, which is located in a town of about 11,000 inhabitants, excited admiration on account of the size of the town that could boast of such an institution, for although the work shown was in close proximity to that from the schools of the same class in Paris and the departments, it was able to hold its own in machine work, and in the matter of architectural wood work it easily took the lead.

The National School of Clocks, of Cluses, made, perhaps, the most carefully arranged exhibit, as all of the parts of clocks and watches were shown in such a way that their relations with each other could be quite easily understood.

Public Assistance of Paris provides an apprentice school for those children who have been abandoned by their parents, and for those who are of such a character as to be undesirable in the common schools (corresponding to our houses of refuge and reform schools), and the work shown as that of pupils indicates an excellent management and considerable interest taken by the pupils in their work.

The Chamber of Commerce has under its protection three schools specially intended for training youth in business principles and

forms. These seem to be arranged on a fairly good plan, with more attention paid to teaching those things which will aid in business decisions than to penmanship, which forms such a conspicuous part of the course in the average America college.

The High Commercial and Industrial School of Bordeaux is an example of the progressive institutions which try to keep abreast of the times and teach those things that have not become obsolete. As a college for merchants it is worthy of many imitators, and as a trade school it is good.

The apprentice schools for wagon and carriage makers, at 22 rue Laugier and at 35 avenue Wagram, exhibited quite nicely their methods for teaching the designing and execution of all work connected with the trade.

The "Elisa Lemonnier" schools were well worthy of our attention as they exhibited a part of the great work that they are doing for the girls and women of France. The work in dress designing and making is excellent and so is the tile and pottery decoration.

The Free Professional School of Design and Modeling of Paris does a fine work among the same class of people, and the specimens of artificial flowers, that were shown as exercises, in an examination of limited time, showed great proficiency. The art bronzes, jewelry, and engraving exhibited the same high grade of work.

In the Paris pavilion we found a new institution, and one that is bound to exert a great influence upon the furniture designers and workers of all France. The work is hardly more than begun, but that which has already been accomplished gives promise of most excellent results. The course includes instruction in designing, cabinet-making, and upholstery.

For scientific instruction in the trades no city in the world can offer better facilities than Paris.

France exhibited more than one hundred and twenty-five excellent institutions of this class.

UNITED STATES.

In the United States, as is well known, nearly all of the institutions of this class are private, although quite a number of States maintain one or more technical courses in their universities, and a few of the cities have established manual training schools which form a part of their public-school systems.

Of the purely technical schools of the highest grade and private in management, we found the Rensselaer Polytechnic Institute, the Massachusetts Institute of Technology, and the Stevens Institute of Technology. The first is specially noticeable for the breadth of its course of study and the results of its work as exhibited by the professional careers of its graduates. This was the first school of the kind to be established in America, and after many years of ex-

perience has concentrated its whole attention upon one course of study intended to make educated civil engineers in the broadest sense of the word. The graduates receive the degree of civil engineer [C. E.]

The last is an example of another class of technical schools that devotes its whole attention to one course of study, and it is believed that one who has received the degree of Mechanical Engineer from Stevens Institute of Technology has obtained as good an education in mechanical engineering as it is possible for any school to give.

The Massachusetts Institute of Technology represents yet another class which believes it better to divide engineering into its many branches and provide a special course for each.

Whether the school training of a mining engineer should differ materially from that of a railway, hydraulic, electrical, or mechanical engineer or not, and whether any man can be a well-educated civil engineer without a fundamental knowledge of all the branches or not, will not be discussed in this place. The Troy school seems to believe that the same school course is of equal value to all, while the Boston school provides a course for each specialist.

In Boston all students follow the same course of study for one year. At the beginning of the second year each must have decided the special branch of engineering that he proposes to follow, and is then supposed to devote his attention to the special course laid down for his selected branch. Ten courses are offered, of which six are professional and four scientific.

Without doubt this institution is well fitted to do the best of work. Its buildings and laboratories are large and well filled, its working libraries are excellent, and its faculty is both large and efficient.

Cornell and Lehigh Universities are examples of institutions that maintain one or more technical courses in connection with those of philosophy and the arts..

Cornell University divides engineering studies into various courses, and each student must select a specialty, to which he is expected to devote his attention. This institution received from the legislature of New York the land granted to the State by Congress for the encouragement of agricultural and mechanical institutions of learning, on account of which it furnishes over five hundred free scholarships to residents of New York State. Its great endowment has given it the power to provide commodious laboratories, museums, libraries, etc., and these have been built and furnished most generously. Its faculty contains men of world-wide reputation. A student should do the best of work with the facilities offered.

Lehigh University is of the same grade, in which instruction is free, due to the generosity of Asa Packer. The work done is excellent and the institution is filled with students.

The Alabama Polytechnic Institute is an example of the technical

schools supported by State governments and exhibited some very good drawings as the regular work of students.

The University of Illinois, an older institution of the same class, was most favorably received in Paris in 1878, and exhibited some good drawings in 1889.

It is not to be gathered from these remarks that the institutions mentioned are the only ones in the United States, but that they were exhibited in Paris and are excellent examples of their classes. In this line we should congratulate ourselves, not that we are well supplied with these valuable schools, but that we have a few such excellent examples to be copied as the generosity of States and individuals shall permit.

In the class of secondary technical schools we do not find ourselves as far ahead as we might wish, but we exhibited two excellent institutions—the St. Louis Manual Training School, private and the Philadelphia Manual Training School, public—as examples of our schools of this class. Both of these schools were much admired in Paris, and we can only regret that we have so few of the kind. Although we have few at present, the prospect is good for a rapid increase in the number as soon as the people can discriminate between the pedagogic and trade properties of manual training. Manual training should be used in public schools for its pedagogic value, and it does not seem to be a point against it that it is at the same time preparing the pupils to make more rapid progress in the acquirement of a useful trade.

The Women's Art School of Cooper Union exhibited one branch of the great and good work that is being done by that institution.

The best class of commercial schools was represented by the Eastman Business College.

The free evening drawing schools of the city of Boston showed the efforts that are being made to disseminate among the working classes a knowledge of drawing and designing that is so important in this age when "cut-and-try" method has given way to the "work to scale" method.

Of the trade schools, such as were exhibited by France, we showed very few at Paris; but it seems proper to state that within the last few years several have been started in the United States and are doing good work.

OTHER COUNTRIES.

Belgium made a very good collective exhibit of professional and trade schools.

Japan merits our applause for the great advance made in this work within the last decade. Its national schools of arts and trades and of commerce are examples worthy of many imitators.

Denmark exhibited the work from a school of design for young ladies at Copenhagen, and the extent and fine quality of the display were particularly noticeable.

Sweden made a very nice exhibit of the "Sloyd" in all its details. In the countries of north Europe this is the class of manual labor that is most favored for schools, because it keeps the parents' interest by causing the products of the child's labor to be useful household articles.

Holland showed good work from the School of Industrial Arts of Haarlem, from the School of Arts and Trades of Leyden, and from the School of Mechanics of Amsterdam.

Mexico took high rank in this class on account of the recent rapid strides which have been made in that country in introducing the new methods of doing educational work. The national schools of arts and trades for both sexes showed results of energy and good judgment on the part of their directors. The National Commercial School is also worthy of particular notice.

Uruguay sent an exhibit from the School of Arts and Trades of Montevideo.

Portugal made a very good exhibit from the Commercial and Industrial School of Lisbon.

Brazil showed the works from the Institution of Arts and Trades of Rio de Janeiro, and from the orphanages of Santa Isabel at Pernambuco, and of Notre Senora de Esperança at Bahia.

Spain sent an exhibit from the Association of Industrial Engineers of Barcelona.

Switzerland exhibited work from the girls' schools of Zurich and Locle and the technical schools of Wintherthur.

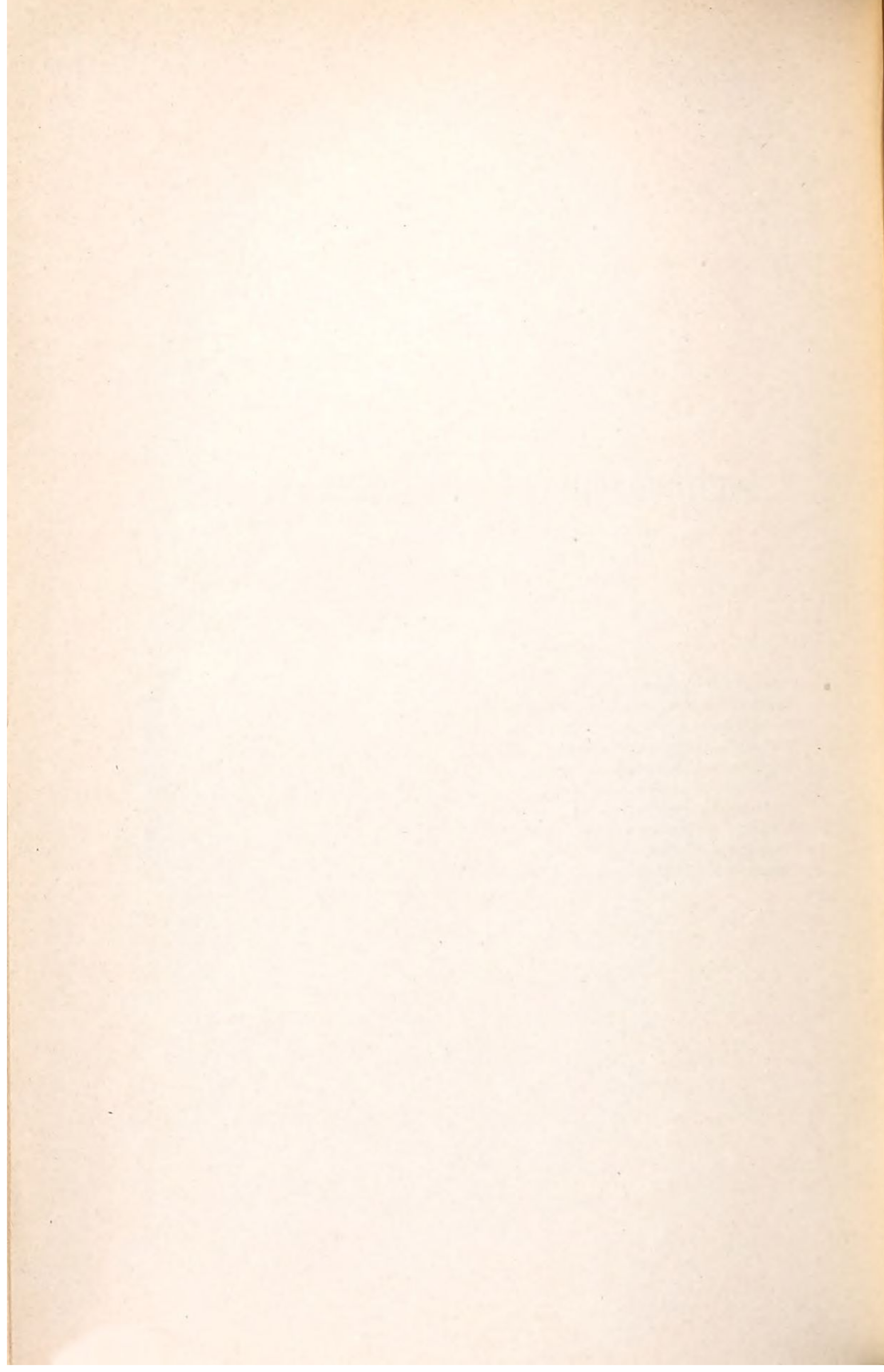
Chili sent an extensive exhibit from the Professional School for Girls of Santiago.

As little had been heard of this class outside of France before the Exposition opened, of course the other nations could hold no comparison to France in the number and variety of exhibits, but enough was to be seen to indicate the tendency of the age and the remarkable unanimity with which the same ideas regarding educational reform are being embraced.

PHOTOGRAPHIC PROOFS AND APPARATUS.

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PHOTOGRAPHIC PROOFS AND APPARATUS.

By Prof. SPENCER B. NEWBURY, Cornell University.

The exhibit of photographs and apparatus at the Exposition occupied a portion of the galleries on the second floor of the Palace of Liberal Arts. As a whole, the display was remarkably fine, and served to illustrate in a striking manner the many important advances that have been made during the past few years in all branches and applications of photography. Naturally the French exhibit was more extensive and complete than that of any other country; in point of general excellence, however, the English section appeared to take the lead, both in apparatus and specimens of finished work. The French exhibit was rendered especially interesting by a full display of the recent scientific applications of photography to medicine, astronomy, and the study of animal locomotion.

PHOTOGRAPHIC LENSES.

The introduction and universal adoption of the gelatine dry-plate process for making negatives has produced a great change in the type of lenses generally used for portraiture. With the long exposures required by the old wet collodion process it was essential that as much light as possible should reach the plate, and therefore in the portrait lenses formerly used the qualities of flatness of field, correct perspective, and depth of focus were all sacrificed to the one consideration of *light*. With the new process, which requires from twenty to sixty times less exposure, it is found possible to replace the old-fashioned, bulky portrait lenses, with their many imperfections, by *rectilinear* lenses of longer focus, which formerly could only be used for outdoor groups, architectural views, and copying. This change has produced a great improvement in the sharpness and freedom from distortion of the portraits taken. The manufacture of lenses of the rectilinear type has greatly extended, and certain well-known makers now find it impossible to furnish instruments of this kind at the rate necessary to satisfy the enormous demand. Ten years ago there were only three or four manufacturing opticians making lenses of first-rate quality, now there are probably more than a dozen new firms whose instruments can hardly be distin-

guished, in point of optical perfection, from those of the most famous makers. Among the newer firms exhibiting lenses of excellent quality were C. Berthiot, J. Zion, E. Français, and Fleury-Hermagis, of Paris. The well-known house of A. Darlot was also represented by a large exhibit. Each of these firms showed sets of combination lenses, consisting of a series of glasses arranged to fit a single mounting, thus giving a variety of rectilinear objectives of different focal lengths. The use of lenses of this convenient and portable form seems to be increasing. The "iris diaphragm" is coming extensively into use, and appears on a number of modern lenses.

In the English section a fine exhibit was made by the well-known firm of J. H. Dallmeyer & Co., of London, consisting of photographic lenses, telescopes, and microscopes. The familiar types of lenses which have long been highly esteemed, such as the rapid and wide-angle rectilinear and the rapid landscape, were represented, as at the last Exposition. In addition to these Mr. Dallmeyer has introduced the "rapid long-focus landscape lens," specially designed for views requiring a small angle; also the new "rectilinear landscape lens," which has been patented within the past year. This is a new departure in photographic optics, and consists of three glasses united in one combination, and so constructed as to produce the full brilliancy of effect characteristic of single lenses, while it gives also absolutely straight lines up to the edge of the plate. This lens is therefore available for architectural views and copying, as well as for landscapes.

Another important exhibit in the English section was that of Ross & Co., of London, whose portable and rapid symmetrical lenses have long been highly esteemed.

A great number of new and ingenious shutters for instantaneous photography, of a great variety of forms, were exhibited in the French and English sections. These are generally designed to be placed between the lenses, and require the construction of a new lens tube to adapt them to any given objective. The principal fault of most forms of shutters is, that they do not allow sufficient latitude of exposure, the slowest action being too rapid for many purposes. One of those which best overcome this defect seems to be that which is now sold in this country under the name of the Newman shutter, and which was displayed under several different names at the Exposition. This instrument may be so adjusted as to give, with a single impulse, exposures of from one second to one one-hundredth of a second, and is certainly extremely convenient for work under varying conditions of light and sensitiveness of plate. In the French section shutters of this type were shown, arranged to act through the diaphragm-slit, thus making it unnecessary to change the lens mounting.

PHOTOGRAPHIC CAMERAS.

The display of cameras and other apparatus was very extensive, but contained very little that could serve as a pattern for our leading American makers. It is greatly to be regretted that our most successful manufacturers of photographic apparatus failed to send exhibits, for a careful examination of the instruments shown at the Exposition leads the writer to believe, as he had previously suspected, that there are no cameras made in any other country which equal our own in convenience and simplicity. This is largely due to the fact that in Europe photographic apparatus is supplied by a great number of small makers; the work is largely done by hand, and the designs are clumsy and old-fashioned. This is all in marked contrast to the methods followed by certain New York firms, who often send to the factory an order for a thousand cameras of a certain size and pattern. England alone showed cameras of excellent quality and practical design; they appeared, however, to be much more complicated than those made in this country, and are sold at very high prices. Probably the best exhibit of apparatus in the English section was that of Watson & Sons, London, who showed very beautiful tourists' cameras of fine finish and delicate mechanism, but far higher in price and less simple in design than American instruments combining all the same adjustments. Shew & Co., of London, showed a number of very ingenious pocket cameras, arranged to fold up into very compact form. These appeared to be the best instruments of the kind among a great number of hand-cameras shown in the French and English sections.

In the United States section the Eastman Dry Plate and Film Company, of Rochester, made a large exhibit of their apparatus, roll-holders for films, cameras, and specimens of prints and enlargements. Much attention was attracted by the "Kodak" camera, which has come into very extensive use among amateurs in this country and Europe. Fine enlargements from "Kodak" negatives were displayed as evidence of the quality of work which these little instruments will yield in skillful hands. Larger sizes are now made, by the aid of which pictures of a more ambitious character may be taken. The Kodak camera certainly reduces the difficulty and labor of photography to the lowest possible point.

MOESSARD'S PANORAMIC CAMERA.

The production of panoramic pictures by means of a lens revolving on a vertical axis, long ago successfully accomplished, has been brought to great perfection by P. Moessard, of Paris. The invention has been rendered far more practical than formerly by the introduction of flexible sensitive tissue which may readily be bent into the semi-cylindrical form required. Moessard's apparatus consists of

a semi-circular camera, provided with a lens so mounted that it may be revolved through an angle of 170 degrees. The sensitive tissue is contained in a flexible plate holder which is clamped in place at the back of the apparatus. A diaphragm provided with a vertical slit is placed in front of the lens, cutting off the whole of the image from the plate except a narrow vertical band. On revolving the lens by means of a lever this band of light traverses the sensitive surface from end to end, thus impressing upon it the whole of the view included within the angle of rotation. It will be readily understood that all rays entering the lens from the horizon strike the film normally to its surface, therefore the image is at all points as sharp and correct as would be a narrow vertical strip in the center of a photograph taken in the ordinary manner. In this way all the distortion and want of definition produced at the ends of the photograph by ordinary wide-angle lenses are avoided; the vertical angle is so small that no distortion is apparent. The apparatus is made in various sizes, employing lenses of 10 to 50 centimetres focus, and producing pictures up to 16 by 56 inches in size. The examples of work done with the "cylindrographe" exhibited by M. Moessard are remarkably fine; especially striking are the beautiful panoramic views of the Exposition, more than 4 feet in length, taken from the towers of the Trocadero and from other points. The invention is fully described, with a discussion of the theory of the apparatus and its possible applications in topographical surveying, in a small book by M. Moessard, in two parts, "*Le Cylindrographe Photographique*" and "*Le Cylindrographe Topographique*," published by Gauthier-Villars, Paris.

ENJALBERT'S AUTOMATIC CAMERA.

An ingenious device for automatic portrait photography was displayed by E. Enjalbert, of Paris. This consists of a camera upon a pedestal and chair for the sitter, the whole designed to be placed in some public situation. On the front of the instrument is a pointer and dial bearing the words, "preparation of plate, collodionizing, evaporation, silver bath, draining, attention, exposure, development, fixing, washing, drying, varnishing." The sitter drops a 10-centime piece into the slot and takes his place in the chair. The pointer revolves, indicating the various stages of the process, and at the end of the exposure a bell rings. Finally a small finished ferrotype-portrait of the sitter appears in a box below the instrument. The specimens of work shown were not remarkably beautiful, nevertheless the apparatus deserves notice on account of its ingenious and effective mechanism.

MISCELLANEOUS INVENTIONS.

M. Dessendier, of Paris, exhibited an interesting registering photometer, the action of which depends upon the effect produced by light upon a current of chlorine and hydrogen gases liberated by electric decomposition of hydrochloric acid. This action was long ago made use of for the measurement of the intensity of light by Draper, Bunsen, and Roscoe. Dessendier's instrument accomplishes this by the passage of the gases, after exposure to light, through hydrochloric acid solution; by the increase of volume of this liquid, due to the absorption of the hydrochloric acid produced, the intensity of light is measured.

Another device exhibited by the same inventor is an automatic apparatus for making photographic prints from negatives. The exposure is controlled by the photometer described above, and an ingenious mechanism removes the print and places fresh sensitive paper under the negative at intervals varying with the intensity of the light. The apparatus is probably too complicated and costly to find extensive use, but is nevertheless a clever solution of a difficult mechanical problem.

PHOTOGRAPHIC PROOFS.

The display of finished photographs, chiefly from France, England, and Switzerland, was probably superior to that at any previous Exposition. In the specimens shown, the effect of the great progress in instruments and processes which has been made during the past decade was strikingly evident. The architectural views showed remarkable straightness of lines and correctness of perspective, due to the use of improved lenses. In landscape and portrait work, also, there was to be observed a fullness of detail, transparency of shadows, and delicacy of foliage and drapery which can only be attributed to the introduction of highly sensitive gelatine plates. The same cause has led to the great progress—almost the creation—of instantaneous photography, which was illustrated at the Exposition by many very wonderful exhibits. Marked advances were also noticeable in the artistic posing and lighting of sitters and in the production of truly artistic and novel effects of light and shade in landscape studies.

In photographic printing processes no great changes have taken place, and for most purposes the silver-albumen process, in spite of its great drawback of lack of permanence, still retains its supremacy. The beautiful platinotype process has, however, shown itself capable of effects of wonderful delicacy. The rich, velvet-black tone of the platinotypes, and their freedom from the glossiness of ordinary photographs, make them very restful to the eye, while their imperishability gives them a special value.

SCIENTIFIC APPLICATIONS OF PHOTOGRAPHY.

An interesting series of pictures, illustrating the use of photography in recording cases of disease was shown by Dr. Londe, director of the photographic service at the *Salpêtrière* Hospital. Among these were a number showing various phases of nervous diseases, taken in the clinic of Professor Charcot. The apparatus employed in this work, designed by Dr. Londe, was also exhibited, and consisted of a camera with electric attachment for making exposures.

The use of photography in military operations was illustrated by exhibits of the French minister of war and Mr. Gaston Tissandier. The latter, celebrated for his experiments and studies in aëronautics, and for the many daring balloon ascensions which he has made, exhibited a series of views taken by himself and Mr. Ducom from the car of a balloon at various altitudes. One of these, taken with the lens pointing directly downward as the balloon passed over the Seine at Paris at a height of 600 metres, is remarkably distinct, and shows the buildings, bridges and steamers on the river in excellent detail. Another, giving a bird's-eye view of the town of Sèvres and the highway to Versailles, taken from a height of 800 metres, on the 2d of July, 1886, is more picturesque, while equally surprising in definition. These pictures, with those lately taken in England by Mr. Shadbolt, represent the most successful achievements in this field, and serve well to illustrate the value of balloon photography in military operations.

Mr. Tissandier exhibited also a number of pictures showing the application of photography to the study of astronomy and meteorology, consisting of views of the sky taken with a fixed camera, showing the path of the sun across the field, traced by instantaneous exposures at intervals of five minutes. Similar views of the moon were taken with continuous exposure, in which the path of the satellite is shown by a bright band across the sky.

The remarkable works of M. Marey, Chief of the Bureau of Animal Locomotion at Paris, in the application of photography to the study of the motions of men and animals, was illustrated by a full exhibit. These experiments are similar in purpose to those of Mr. Muybridge, of San Francisco, whose excellent results are well known. Mr. Muybridge, however, employs a series of cameras placed side by side, which are successively exposed as the object passes before them. M. Marey uses a single camera facing a wide black background, in front of which the moving body passes, while successive exposures are made by the aid of a perforated revolving disk. The result is a row of images extending from end to end of the plate. A large chronograph, with a revolving white hand, the successive positions of which appear in the picture, shows the interval of time which separates the images, while a scale of metres at the base of the

background gives the data necessary for calculating the velocity of motion. The specimens shown reveal most strikingly the various attitudes assumed by men and horses in running, walking and leaping, the flight of birds, the path of projectiles, etc. The theory of the process and its value in the study of the laws of motion has been fully discussed by Prof. E. J. Marey in the *Archives de Physiologie* (July, 1889); an account of the experiments, with examples of the results obtained, may also be found in the *Scientific American Supplement*, 1883, pp. 6514 and 6601.

“Photography without an objective” was illustrated by R. Colson, of Paris, in a series of interesting views produced by the rays of light passing through a fine aperture. The “pinhole camera” has been known from the earliest days of photography, but it is only since the introduction of highly sensitive plates that it has been possible to make practical use of this simple device. Mr. Colson has worked out the theory of this primitive instrument with great care, and has given a full account of his experiments in a pamphlet, “*La Photographie sans Objectif*,” published by Gauthier-Villars (Paris, 1889). The author finds that for a distance of 8 centimetres between the plate and the opening the latter should have a diameter of three-tenths of a millimetre; for a distance of 30 centimetres a diameter of five-tenths of a millimetre gives the best results. Under these conditions a well-lighted outdoor view requires only from 10 to 40 seconds’ exposure. The pictures produced are not absolutely sharp, but are sufficiently so for many purposes, and possess certain advantages over those made with a lens, viz, great width of angle, exceeding 90 degrees, and absolute freedom from distortion and incorrect perspective, which are present in ordinary photographs to a greater extent than is generally supposed. The process is especially useful in topography, in cases requiring absolute correctness of lines. Among the views shown, one of the most interesting is a perspective of the Dôme des Invalides, taken at a distance of only 100 metres from the entrance, a copy of which forms the frontispiece of the book mentioned above. This picture is very pleasing, and forms an interesting study in perspective.

In the United States section one of the most remarkable achievements in the application of photography to scientific research was shown in Prof. H. A. Rowland’s Photographic Map of the Normal Solar Spectrum. This map is in nine sections, each 3 by 2 feet in size. The negatives were made at the Johns Hopkins University, Baltimore, with the aid of Professor Rowland’s well-known concave grating. The great advantage of this instrument is that it gives a spectrum which is normal, and may be measured by the same scale from end to end. The negatives from which the map is printed were taken on specially prepared plates, which, for certain parts of the spectrum, were stained with cyanine and chlorophyll.

The scale is three times greater than that of the standard map of Angström. The most remarkable features of this set of photographs are their extraordinary definition, and the perfection with which the portion of the spectrum lying beyond the ultra-violet is represented. In these respects, and in many others, the map is a great advance over anything heretofore accomplished in the photography of the spectrum.

PHOTOGRAPHIC PROOFS AND PROCESSES.

Beautiful instantaneous views were to be found in the exhibits of all countries, showing the capabilities of modern highly sensitive plates and rapid shutters. Among the finest may be mentioned the running and leaping horses of H. de Perpigna, of Royan, the marine views of Grassia, of Boulogne-sur-Mer; and, in the English section, the beautiful views of racing yachts under full sail, exhibited by G. West & Sons, of Portsmouth. The latter, 14 by 17 inches in size, are the finest examples of instantaneous photography, both from an artistic and technical point of view, that the writer has ever seen.

In portrait work the chief advances were to be noticed in the matter of softness and delicacy of shadows and richness of detail, which are doubtless to be ascribed to the greater sensitiveness of the gelatine process and the better control it allows in development. The French section contained many examples of fine work; the palm for highest excellence in this field must, however, be awarded to the English. The remarkable life-size portraits of the royal family, by Walery, of London; the beautiful full-length figures by Lafayette, of Dublin; and the charmingly composed portraits of ladies and children, by Burnside, of Guernsey, Thomson and Van der Weyde, of London, were beyond all praise, and in point of composition, lighting, and perfection of detail, left nothing to be desired.

The United States was also creditably represented in portrait photography. Sarony, of New York, showed two large frames of very excellent portrait work; Scholten, of St. Louis, and Guerin, of the same city made large exhibits, including a number of striking life-size heads; good work was also shown by Bloch, of Brooklyn; Falk, New York; Decker, Cleveland; D. R. Clark, Chicago, and others.

A notable feature of the portrait exhibit from all countries was the very extensive use of the platinotype. Many of the most beautiful pictures shown were examples of this comparatively recent process, which is proved to be capable of yielding results in many respects more pleasing than silver prints, and possesses the added advantage of absolute permanence.

The use of flexible tissues instead of glass, as a support for the sensitive film, has also made great progress. Exhibits of gelatine films and negatives were made by several French manufacturers. The greatest advances in this field appear, however, to have been

made by American inventors. The Eastman Company, of Rochester, has introduced stripping films and transparent tissues which are largely used in the United States and England; while Carbutt, of Philadelphia, has succeeded in making transparent celluloid available for this purpose, and is now making sensitive celluloid films which have come widely into use, and yield results fully equal to those which may be obtained on glass plates.

Another branch of photographic manufacturing which has attained a high degree of excellence in the United States is the preparation of gelatino-bromide paper. Very fine bromide enlargements were shown by Morgan & Co., of London and Paris, and the Eastman Company, of Rochester, N. Y. Specimens of work on the Eastman paper were also shown by Nadar, of Paris.

The use of the carbon process does not seem to be on the increase. Braun, of Paris, made a fine display of his well-known reproductions of paintings; these are very beautiful and of undoubted permanence, but are very costly.

The cyanotype, or blue-printing process, chiefly used for copying drawings, has lately received an important modification which makes it possible to produce positive impressions, showing blue lines on a white ground. Paper prepared for this process and specimens of excellent results obtained with it were shown by Mlle. Joltrain, of Paris. The paper is probably prepared in much the same way as directed in the *Journal of the Society of Chemical Industry* (1888, p. 766), by coating it with a solution of tartaric acid, gum arabic, and ferric chloride. The exposure is very short, only fifteen to forty seconds in bright sunlight; the prints are developed by immersing in a 20 per cent. solution of potassium ferrocyanide and fixed by washing with dilute acid. The process appears very simple and should prove of value to manufacturers and draftsmen.

Many beautiful examples of landscape photography were to be found in the exhibits of several countries. In the Swiss section the fine views shown by Flury, of Pontresina, and Mlle. Hinnen, of Zurich, were especially noted. The French exhibit was also rich in fine outdoor studies. Nothing shown by European countries, however, could be called superior to the remarkable views of Niagara Falls and Florida, taken by George F. Barker, and shown in the section of the United States.

One of the most important features of the American photographic exhibit was the display of large transparencies of Western scenery, exhibited by the United States Geological Survey. These were effectively displayed and attracted much attention on account of their photographic excellence and the interesting character of the subjects they represent.

Lantern slides, made by the albumen process, and of microscopic

fineness of detail, were exhibited in great number and variety by the well-known French firms J. Levy & Cie. and Lachenal & Cie., of Paris.

PHOTOMECHANICAL PROCESSES.

Comparatively little of importance in this branch was brought out at the Exposition, and the details of the processes followed are still generally kept secret.

The Goupil Company (Boussod, Valadon & Cie.) made a large exhibit of their processes of *photogravure* and *phototypogravure*. The photogravure process, in which the picture is printed from an etched copper plate prepared by the aid of photography, was first brought out by this company, and has never been brought to so high a degree of perfection by any other firm. The photographic part of the process is kept strictly secret, but the operation of printing from the finished plates is carried on at the factories at Asnières, near Paris, in much the same manner as the printing of steel engravings. A novel modification of the process is the production of *photogravures in color*. This is accomplished by inking the plate in black, as usual, and then working it over with colors applied by means of a stub. When printed, the tints underlie the black shadows and half tones, giving a colored picture of great softness and beauty. The application of the colors is a delicate operation, and requires much taste and skill on the part of the workmen. From one to four or more impressions per day can be produced from each plate. The *phototypogravures* are similar to the well-known "process pictures" produced by the Ives and other processes, and now largely used in this country in the illustration of the leading monthly magazines. These are obtained from a gelatine relief-mold, by breaking up the shadows and half tones into stippel-work by means of a perforated screen. The process has been rapidly improved during the past few years, and pictures of large size are now readily obtained. The finished plates are reproduced in electrotpe, and may be printed with type on an ordinary press. Several of the French weekly journals are illustrated with excellent photo-typographic pictures, often of the size of the double quarto page. Probably the most striking of these which have lately appeared are the views of the Exposition published in the *Paris Illustré*. The Goupil Company are producing these pictures largely, with the addition of colors, printed successively from blocks, in a number of tints.

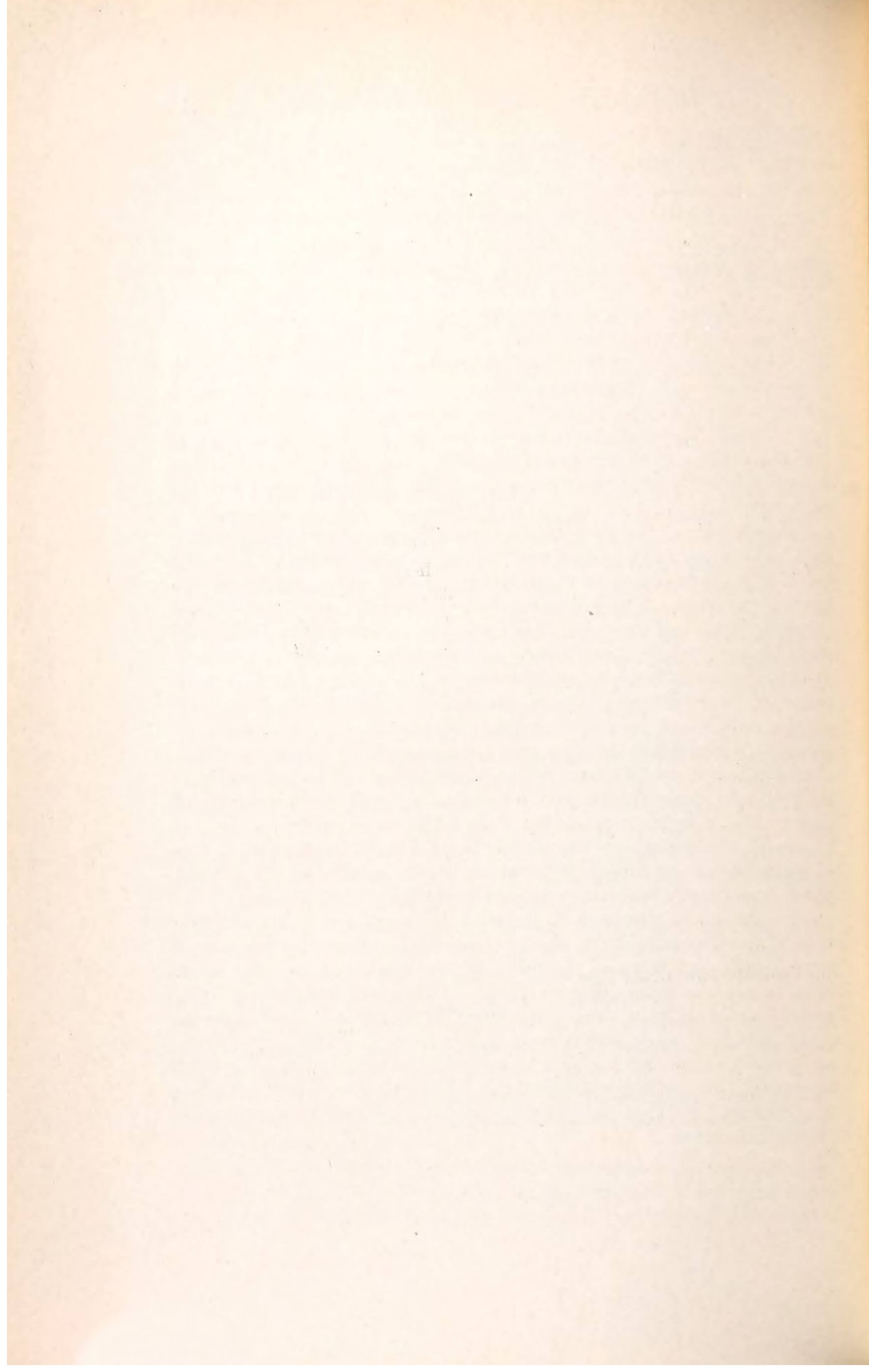
The heliotype or phototype process was well illustrated by the fine exhibits of Dujardin, Berthand, and others, but is too well known to require description.

An interesting application of heliotype printing is found in the production of photographs in color by the Ducos du Hauron process, specimens of which were shown by Quinsac & Bacquié, of Paris.

The experiments of M. Ducos have been known for many years, but the process has only very lately been made industrially applicable by the above firm. The method employed consists in taking three separate negatives, through colored glass screens, of the object or view to be reproduced. From these negatives gelatine phototype plates are made as usual; these are then coated with yellow, red, and blue inks, respectively, and printed in succession upon the same sheet. The combination of the three colors produces black, forming the shadows of the picture, while all possible tints are produced in their true positions by the blending of the three colors in different proportions. The negatives are taken through glasses of colors which are complementary to the tints subsequently employed; thus, for the reds a green glass is used, for the blues an orange glass; for the yellows, which would in theory require a violet glass, a simple instantaneous exposure without any colored screen is found sufficient.

The operation of taking the negatives is one requiring great care and skill, since only by exact adjustment of their relative intensity can the proper balance of the respective colors in the resulting picture be secured. The negatives taken through green and orange glasses require an exposure of several hours. Since the lights and tints of an outdoor view change greatly during so long a period, it is found very difficult to secure harmonious results, and the landscapes obtained often show very eccentric effects of color. It is stated by the exhibitors, however, that Mr. Ducos has found a means of greatly diminishing the required time of exposure, and that this obstacle has therefore been happily overcome. In indoor work no difficulty is encountered, and paintings, colored designs for wall paper, etc., may be reproduced with absolute accuracy. The expense of the process is necessarily very considerable, but it has already found important application in the production of colored plates and covers for certain finely illustrated books.

The exhibit of Quinsac & Bacquié included a number of very beautiful views of scenery, the most successful of which was one of the church and town of Lourdes, which might easily have been taken for a fine water-color painting. Although, as is evident from the above description, the actual selection of the shades of color to be employed depends on the taste and judgment of the printer, it is nevertheless true that the *position and distribution* of the tints are determined by photography, and that the process, as a whole, is the nearest approach that has yet been made to successful photography in natural colors.



OPTICAL INSTRUMENTS AND OPTICAL MATERIALS.

By Prof. CHARLES S. HASTINGS,
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The art of lens making is almost the only modern art depending on manual skill alone. In nearly all other departments of skilled crafts it would seem as though the ancients, or the nations of the far East, had excelled the peoples of Christendom not only in fertility of invention and in taste but even in technical execution ; this art, however, having its incentive not in a desire to gratify æsthetic taste but a desire to extend our knowledge of nature, is by that very difference necessarily a product of modern times and of European civilization. Such were the intelligence, the skill, and the perseverance required to develop methods of sufficient refinement for the ends in view ; such were the transcendent intellectual endowments of those who first succeeded in adding to human knowledge by lenses, of which the methods of making were their own inventions and the instruments the fruits of their manual skill and industry, that it is not surprising that all English writers of the last century and early part of this speak of a successful optician as an artist. Another feature of interest in this highly developed art is, that it is possible to trace an almost complete history of its growth. In arts whose birth came before the universal spread of letters this is of course impossible, and all traces of earlier history are either wholly lost or buried under a mass of tradition impossible to verify or disprove.

The Exposition of 1889 was of great interest in this department of industry, not on account of noteworthy novelties, for they were almost wanting ; not on account of the exhibition of the more remarkable achievements of modern optics, for the wonderful improvement in the microscope due to Professor Abbe was represented only by a single instrument from Austria ; but rather in the enormous extent of the exhibits of the Parisian opticians, and the unequalled taste displayed in the details of construction. These features clearly place Paris at the head of industrial centers for the production of what may be styled optical apparatus, to distinguish from those instruments of precision which have always been regarded as mak-

ing the reputation of the maker rather than of a place or class. The fact that this end has been attained by clinging to a technical method invented more than two centuries ago, which is just adequate to the end, is certainly suggestive, though probably not explanatory. What this method is, we shall find in considering the story of the growth of the opticians' art.

In order to make possible an account of the history of optical art it is necessary to define clearly the operations of "grinding" and of "polishing" glass, for the processes are as different in their natures as are the etymologies of the words used to describe them. In the process of grinding, hard grains of quartz, of emery, or of chilled iron are rolled between the glass surface and a plate, generally of some tough metal. In order to render this rolling process easy the grains must not be too uneven in shape or size, and they must be kept wet, for if dry the friction against one another will retard their turning as well as impede their distribution in a tolerably uniform layer. Of the substances named, quartz sand is the cheapest and is generally used for rough work, but it lacks strength, and somewhat rapidly breaks down into a fine powder; emery or the purer corundum, is far tougher, and is universally used in grinding by hand; the last-named substance has only recently come into limited use to replace quartz sand.

The effect of this rolling of irregular grains against the glass, which has a very low limit of elasticity, is to break out minute pieces at each shock of a turning edge or corner, and thus to fill the surface with minute pits. The smaller the grains the smaller the pits, and the smoother the ground surface. If there are one or more large grains they produce, if rolling, a row of larger pits, which necessitates grinding the whole surface down to the extent of their depth. If these grains are held fixed in position, say by sticking in the metal plate, they produce scratches which, though generally less deep than the row of holes, necessitates protracted labor. This process is carried on with finer and finer emery, with ever-increasing danger of scratching, which would bring with it loss of ever-increasing amount of labor, until stopped by these considerations of economy. It will be recognized that this grinding is quite like that of grinding marble and other *brittle* bodies, not at all like grinding tough bodies like metals, which is more nearly allied to the process of polishing.

The essential peculiarity of polishing is, that the fine grains of the polishing powder are held in position—that is, not permitted to roll over the surface to be polished. They thus act as minute chisels or planes, which shave off ultramicroscopic shavings. Thus diamonds are polished by fragments of diamond powder embedded in soft steel, metals by emery imbedded in plates of type-metal, or, when luster only is desired, by emery fastened by glue to paper or leather. It is clear that the sharper the grains of polishing powder

the better, since they are not required to roll, hence emery is never used for polishing glass, as it breaks with rather obtuse angles. The only substances practically which have been used are tripoli powder, which is a native quartz powder largely, perhaps exclusively, consisting of fragments of diatoms; oxide of tin, a white powder known as putty powder; and, finally, an anhydrous oxide of iron known to us, singularly enough, as rouge (*i. e.*, French red) and to the French as English red. This treatment obviously covers the polished surface with fine scratches; but a surface covered with scratches much less than a two hundred thousandth of an inch apart is indistinguishable by any known method from a perfectly smooth surface. It is also obvious that in the process of polishing there is little danger of producing large scratches and an immediate destruction of the product of expensive labor, because, the polishing grains being held upon a relatively soft bed, they will be pressed into that when of excessive size rather than into the glass. From this it is easy to see that it will cost less to finish a surface by stopping the process of grinding at rather an early stage and take to the relatively safe polishing process, but also that it will be impossible thus to secure a definite geometrical surface, since the softer polisher will adapt itself to the glass surface, whatever its form, while in grinding the glass is constantly approaching the form of the relatively unchanging metal plate. These considerations yield a ready definition for an "optical surface." Whenever geometrical form is of the last importance, it is imperative to carry the process of grinding as far as possible and to leave a minimum of change to be made by the inconstant polisher; such surfaces are optical surfaces. But where the object of the polish is to bring out the color of a substance, or, in other words, the same as that of oil or varnish on wood, as in marbles, agates, and other more precious stones; or when only so small a portion of the surface is to be used at one time that that portion may be fairly considered as geometrically regular, as in the cases of spectacle glasses, windows, and mirrors, when the portion used varies from a small area equal to the pupil of the eye up to a greater area determined by the distance of the surface from the eye, then the expensive process of fine grinding, or "smoothing," as it is called technically, may be advantageously replaced by longer polishing. Such surfaces are not optical surfaces in the sense here used.

There is no evidence that the art of grinding and polishing glass in definite geometrical forms was known before a period late in the thirteenth century, though it is certain that at the end of that century spectacles were known and manufactured in Italy. The processes then employed we know almost nothing of, but it is quite probable that they differed little from those still in use. Knowledge of the art gradually spread over Europe, though the methods employed were always jealously guarded as secrets; not until the beginning of the seven-

teenth century, however, is there any evidence that essential progress had been made in these methods. But in 1608 a spectacle maker of Middleburg, in Holland, named Lipperseim, made by accident a discovery which ushers in one of the most astonishing epochs of intellectual achievement known to history, and serves as the introduction to perhaps the most interesting chapter of the history of science. To trace the results of Lipperseim's discovery of the telescope is, it is hardly an exaggeration to say, to trace the history of physical science, and to be brought into contact with every mind, great in physical science, for a period of over two centuries. To trace the history of the telescope itself is to trace the whole optician's art down to a period only a half century ago.

The importance of this discovery and the eagerness with which it was welcomed by a great mind is evident from the fact that Galileo, easily the greatest physicist of his own or any preceding time, had, within two years of the discovery, informed only by report of the wonderful performance of the new instrument, reinvented the telescope, made a number of far greater power than any known in the north of Europe, and finally, having succeeded with infinite pains in making a telescope which would magnify over thirty times, reaped with it a harvest of discoveries in physical astronomy which can never again be approached.

For many years Galileo alone could make telescopes which were of sufficient power to be very useful in furthering astronomical discoveries; but forty-five years after that philosopher's discovery of the satellites of Jupiter, Christian Huyghens, a physicist and astronomer of the very first rank, whose fame has been, and could be, eclipsed by that of Newton alone, had devised a method for making lenses which he had carried to such perfection that he discovered with a telescope of his own construction not only a satellite to Saturn but also the solution to the enigma which had so baffled Galileo—the true structure of the rings of Saturn. Huyghens is of especial interest from our present standpoint, because he left a full description of his methods for securing such unprecedented results, which we shall consider below.

The last-named discovery of Huyghens was not verified nor probably generally accepted until five years later, in 1660, when the Florentine Academicians applied an excellent telescope made by Divini, of about 34 feet in length, to testing the diverse views of the Saturnian system. These observers convinced themselves that the views of the Dutch astronomer were correct, in contradiction to those of Fabri, who, curiously enough, seems to have been the mouthpiece of this very Divini. That the Italian physicists had not remained idle since the cessation of Galileo's activity is also apparent from the fact that the same Academicians declared that a telescope of similar dimensions, made by the famous inventor of the

barometer, Torricelli, the most celebrated of Galileo's pupils, was superior to that of Divini. This telescope still exists in the Physical Museum at Florence.

There was at this time in Rome a bitter rival of Divini, who afterwards far surpassed him, and who, during his lifetime, was probably more celebrated as a telescope maker than any predecessor or follower. That man was Campani, whose name to this day is attached to the form of ocular used more than any other for telescopes and microscopes. He was, to the best of our present knowledge, the originator of the technical methods now employed by the French opticians.

Campani's reputation reached its height with the discovery by Cassini of four more satellites of Saturn and the division of its ring, all these discoveries having been made with telescopes made by the Italian optician. The discovery of the two smallest of these satellites, now known as Tethys and Dione, probably marks the very limit of performance by the old type of telescope, for, though made in 1684, the observations were not generally accepted until 1718, when seen by the English astronomer Pound, with a telescope 123 feet in length made by Huyghens.

Though there is little doubt that Campani's methods were the same as those used later, and were, perhaps, skillful adaptations of the processes employed by the Venetian mirror makers, he held them as the most precious secrets, and permitted no one to enter his shop. Only after his death, when Pope Benedict XIV purchased his tools from his heirs, was the eager curiosity of men of science gratified. No secrets were discovered, except possibly that Campani had employed a paper, of which a large store was present, somewhat different from any then procurable, and perhaps of his own manufacture. Whether the present method of polishing optical surfaces employed in France is really derived directly or indirectly from Campani, or is an independent invention, it is difficult to say positively; we know only that Père Cherubin, in a work entitled "*La dioptrique oculaire*," published in 1671, thus contemporary with the famous Italian optician, describes the method as his own.* Certain it is that in the next century and down to the present time it has been the almost universal method employed in France.

Huyghens' contributions to this art are not of great practical importance; that is, he invented no method of glass working which still survives, and, although he certainly made telescopes which were only rivaled in his time by the best of Campani's, there is no reason to believe that his process ever yielded important results in other hands. But whoever is interested in the history of telescope making, or of the achievements of telescopes, is largely indebted to

* The writer has not been able to consult this work, and the above assertion rests on a statement in Smith's Optics.

this extraordinary man; for he not only left a very minute account of his methods of lens making, in a book published shortly after his death in 1695, but he also left a magnificent telescope of 123 feet in length to the Royal Society of England. This instrument, used in accordance with his plan, without a tube, has been repeatedly compared with modern telescopes, and these comparisons afford a most interesting and exact basis for estimating the progress in optical art.

For the reasons given above we need give little more attention to Huyghens' method of polishing, except to indicate its nature. The essential peculiarity was, that after smoothing the glass the tool was to be coated with a thin uniform coat of a paste made by mixing copper sulphate with tripoli, and moistening the mixture with a little vinegar. This was to be thoroughly dried, and the glass was to be rubbed upon it without moisture. As great pressure was required the lenses were necessarily of thick glass.

We turn now to the consideration of progress of the optical art in England. That telescopes were made there early in the seventeenth century there is little doubt, and it is well known that the brothers Ball discovered the division in Saturn's ring ten years before Cassini with a telescope which was probably of English manufacture. This must have been an excellent telescope for that period, probably sufficient for the discovery of two of Cassini's new satellites, but not necessarily so for the smaller ones. Not until 1668, however, is there any indication that a notable improvement had been made, but in that year the great Newton employed for the polishing of the mirrors for his reflecting telescope a tool of pitch with putty powder moistened with water. This was an almost necessary step in further progress, at least, if Newton's own invention, which subsequently proved of such momentous importance in the hands of Sir William Herschel for the progress of physical astronomy, was not to remain a barren monument of ingenuity. It is quite safe to assert that no metal mirror of good quality has ever been made which was not polished on a tool of pitch or of a substitute having like physical properties.

In all probability, however, Newton himself did not recognize the whole merit of his substituting pitch for cloth or paper or Huyghens' paste; at least it seems fair to draw this conclusion from his method of applying it. He used hard pitch, applied drop by drop upon a warmed tool, and spread it out by means of the concave tool until it was "as thin as a groat." Had he used it as does the modern skilled optician, he would probably have laid stress upon having pitch not too hard, and certainly not have used it in a very thin layer. To make the reason for this assertion clear, it will be necessary to consider the physical conditions which must be observed in order to secure a definite geometrical surface, or, in words which

would recommend themselves to an optician, to consider the philosophy of "figuring" an optical surface.

The older opticians, and indeed probably the majority of modern ones, evidently supposed that the glass, upon leaving the tool after skillful smoothing, was geometrically perfect, and that the process of polishing was attended by a constant tendency to departure from the true form. Thus the process of grinding was pushed as far as the utmost skill could carry it, and as little left for the final finishing as possible. This view indeed seems to have exercised such influence in the past that Cox and Scarlet in England, nearly two centuries ago, used to finish polishing some of their objectives in the metal tools on which they were ground. The process—independently interesting on account of its illustration of the theory of polishing—was to grind with quartz sand and, as the grinding progressed, remove from time to time the comminuted quartz and glass by means of a damp sponge; after a long time this would have removed all the loose rolling grains, and leave nothing but those imbedded in the substance of the tool, constituting what is known to mechanics as a "lap surface," and thus adapted to polishing. This process was even revived recently by the noted French optician Lerebours applying it to the finishing of surfaces for large achromatic telescopes,* though in the case of large surfaces it is necessary to keep the tool constantly wet to escape great friction, and hence to lengthen the time of polishing by an incredible amount.

The natural assumption upon which this tedious process is founded is, however, quite baseless. It is quite impossible to have two solid bodies permanently fit each other along any surface of separation, unless they are so near as to be within the sphere of molecular attraction, in which case they would unite and become one body. That this must be true follows from the facts that no two substances have the same coefficient of expansion, that it is practically impossible to keep bodies unchanged in temperature for any length of time, and that even local differences of temperature are unavoidable if there is to be any attrition. Even if we make the grinding tool of glass also, which would yield the most advantageous conditions, we should not be entirely protected from these important sources of error.

But there are surfaces which may be brought into close agreement and be made to remain so, either with or without molecular contact, namely, the surface of a solid and that of a liquid. If the liquid is very fluid, this agreement will persist even under conditions of rapid change—if very viscous, only under conditions of very slow change. Now the great merit of pitch as a polishing tool is that under slowly

* M. Darlot, the eminent optician, to whom the writer is indebted for much other interesting information concerning the methods employed in Parisian shops, is the immediate source of this statement.

changing forces it is indistinguishable from a liquid, but under quickly changing forces it is a hard and very brittle solid. Thus, to the forces changing rapidly in direction and magnitude which the glass exerts upon a particle of imbedded polishing material, or to those due to the geometrical form being one other than plane or spherical, the pitch is a solid, but the material will flow with sufficient readiness to always keep pace with those slow but inevitable changes of form due to varying distribution of heat. It is always necessary to employ water, or a substitute, between a tool of pitch and a polishing surface, in order to prevent molecular contact. The value of this property of fluidity even goes further, for by keeping the substance in a continuous flow it is possible to so modify the pressure and rate of attrition on different portions of the surface polishing that any regular departure from a spherical form desired can be secured. Thus the older Herschel and Lassell have succeeded in making parabolic mirrors which made telescopes unapproached in optical power until the completion of the Washington refractor; Cuthbert (and without doubt that extraordinary artisan alone) in constructing ellipsoidal mirrors which had a diameter equal to nine-tenths of their focal length, making, for a passing moment, the reflecting microscope the most efficient form existing; and finally, a well-known American optician in constructing the remarkable surfaces which have aided Professors Michaelson and Morley in demonstrating the persistence of a type of light-wave motion vastly beyond what had been dreamed of as possible. The growth of the technical methods resting upon this property of pitch has been very slow but continuous. Having their origin in England, most of the improvements also have been first made in that country. To-day it is the sole method employed for exact work the world over, except in the very capital which easily leads the world in certain branches of optics.

This long discussion of the history of the *technique* of the optical art has seemed justified by its usefulness in explaining the cause of certain superiorities of French opticians, and because, though it relates to subjects treated voluminously by many able astronomers and physicists during more than two centuries it is, perhaps, impossible to find anywhere a critical comparison of the methods which have sustained themselves during a long period and are still in use.

More specifically, the method so often alluded to as characteristically French and not yet described, is the following: After smoothing with more than usual care and skill on tools, which are almost universally of brass, the glass surface is washed with sulphuric acid to clean it from the trace of metal dust which gives it a black color. This cleaning renders much more easy of detection any imperfection in smoothing, either due to scratches not completely ground out by

fine emery or lack of accurate fitting of the glass to the tool. The next step is to fasten paper to the surface of the tool upon which the glass has been ground by means of a paste made by boiling starch. To secure a close fitting between the tool and the paper, all excess of starch is pressed out by rubbing the paper down into place by a short section of a glass tube, of which the rim is ground true and polished—in short, so that the action is just that of a small tumbler turned upside down on the paper, only that the implement used is quite true. This process not only expresses all excess of the paste, but also betrays to the touch all unevennesses and foreign bodies in the paper, which may then be removed by the point of a knife-blade. Should the tool be sufficiently curved, gores must be cut out of the paper, so as to insure close adaptation without folds. If the polishing is to be done on the optician's lathe, the whole surface of the tool or a large part of it may be covered by the paper; but if the polishing is to be accomplished by moving the glass by hand over the tool, it is better to have a strip only lying across the middle of the tool and not wider than the glass surface. This latter arrangement would meet, indeed, somewhat more closely the conditions for accuracy in the finished surface. When the paper becomes quite dry it is rendered uniformly velvety by rubbing with a piece of pumice stone nearly fitted to its curvature, after having scattered powdered pumice stone over it. Then the powder is removed by a brush, and the paper is liberally coated with the polishing material by rubbing with a lump of tripoli of the variety known as *tripoli en pierre*. The polisher is now ready for use, after the expenditure of astonishingly little time and labor compared to what would be required to finish a pitch tool for the same purpose. The glass surface, after being carefully cleaned from all dirt and grease, perhaps by scouring with whiting and water, as well as any way, is rubbed with even pressure upon the prepared surface, and if the smoothing is well done the polish proceeds with gratifying celerity. A final luster is given to the surface after attaining a uniform polish by dusting a little putty powder over the polisher, without, however, removing any of the tripoli which has become embedded in the paper. No hesitation is felt in adding fresh tripoli to the polisher during the process.

As to the kind of paper employed there may be a considerable latitude of choice. A common kind, made expressly for opticians' use, is a rather dense paper of a fine and pure pulp, not thin, having a thickness of about 0.0056 of an inch, and very uniform. It makes a very pretty and uniform velvet when treated with pumice stone as described above. When this is too thick, which would be true for the deeper curves on wide angle camera lenses, it is thinned down, after having been cemented on the tool, by means of a moist sponge. The Henry Brothers, of whose work more will be said below, employ photographic paper fastened to the glass tools upon which they do

their grinding. With them the polisher is round and very nearly the same size as the surface to be polished.

This, then, is the method which certainly originated more than two centuries ago, and by which at the present day the great majority of optical surfaces (always excepting those of very small radius, as has been done tacitly heretofore) are finished. Doubtless it requires great skill to adapt the method to the varied demands made upon it, but granted the skill, the method has most notable advantages. It is rapid,* cleanly, as only white powders are used and always in a dry state, independent of the temperature of the room in which the work is done, and, finally, quite accurate enough for a vast range of requirements. For prisms and lenses used in lecture demonstrations; for lanterns and heliostats; for polariscope work of almost all kinds; for lenses for opera glasses and for cameras; and, finally, for small telescopes for other than astronomical purposes, it is just sufficiently accurate. Certain it is that it far excels the familiar method of polishing on cloth with rouge, in accuracy, and probably in cheapness. On the other hand the writer has never seen a prism finished by this method which would meet the requirements of a critical spectroscopist, though he has examined very many; it is probable that none but the Henry Brothers have succeeded in making achromatic telescopes of such first-rate excellence as the work of the Clarks and of Brashear have taught American astronomers to demand; the polish is not so brilliant as that produced by rouge on pitch; and, lastly, the method does not possess that plasticity which renders it comparatively easy to secure parabolic and ellipsoidal surfaces.†

The preceding introduction, explaining as it does in part why the Paris Exposition is so rich in optical work, will enable us to review more succinctly its notable features. We will consider the objects exposed in the order of their scientific interest, rather than in order of their industrial importance. This plan is arbitrarily chosen because it admits of a more logical classification of the exhibits.

TELESCOPES.

The only makers who presented telescope objectives of large size and of special scientific importance were the Henry Brothers, Paul and Prosper, of the Paris Observatory; but a glance at the collection

*The writer was introduced to a working optician in Paris a number of years ago, who, he was assured, completed 144 eye lenses for opera glasses every day of the week. The feat was represented as a very extraordinary one by both his informants.

† Foucault has described a method, in a famous paper published in "Annales de l'Observatoire de Paris," entitled, "Mémoire sur la construction des Telescopes en verre argenté," v, p. 197, for securing a parabolic figure in a glass telescope mirror. The method is ingenious rather than refined, and would hardly yield a first-rate result.

of their work could hardly fail to awaken admiration in the observer, even if he was ignorant that there are a large number of objectives from the same indefatigable makers in constant use in various parts of France. In the case devoted to their work were the following notable products:

A photographic objective of 24.4 inches aperture, for the Meudon Observatory.

An objective of 7.87 inches aperture, to serve as a finder for a photographic telescope.

An objective of 23.6 inches aperture, to be employed in an equatorial *coudé* for the Observatory of Paris.

An objective of 17.3 inches aperture, for the Observatory de la Plata.

An objective of 13 inches aperture belonging to the makers.

Finally, an objective of the same dimensions as the last named, but corrected for photographic work.

There certainly has never been another occasion when so large an amount of skilled work of this kind could have been seen collected together in one place. It is worth noting that the magnificent pieces of optical glass here employed were also made in Paris.

Of mounted telescopes, with apertures from 6 inches downwards, there were a very great number. The old wooden frame mounting, which was represented by several examples in the Philadelphia exhibition, seems to have become quite obsolete, although much can be said in favor of its lightness, rigidity, and cheapness. It is, indeed, the only portable mounting that will enable one to observe satisfactorily, when the object is not too near the zenith, with a large telescope. Nineteen-twentieths of the mountings were of the old and thoroughly bad "cradle joint" types, in which a change of a few degrees in altitude so changes the position of the center of gravity in the moving parts that, unless the joint works with very inconveniently great friction, the tube will not retain its direction without clamping. If these telescopes are only to be used as terrestrial spyglasses this would be no serious objection, but for any astronomical use it is very inconvenient. There appeared to be only a single telescope mounted on horizontal and vertical axes in a rational manner, so that the instrument is balanced in all positions and at the same time in an economical manner. This was a small instrument exhibited by an English maker, which will be noted below. A considerable number of makers exhibited telescopes equatorially mounted, though as a rule the success of the designs was not great. A common and eminently natural fault was overelaboration of the adjustment for latitude, this portion of the mechanism being often finished with all the care which might be profitably expended upon the motion in declination, but which here clearly indicated insufficient knowledge in the designer of the true purpose of the mounting.

One maker put the whole mounting of a 4-inch equatorial above an elaborately finished cradle joint; but the most grotesque arrangement was that of another maker, where the latitude adjustment was also a cradle joint, but with the accessories of a heavy counterpoise at the lower end of the *hour* axis and a steadying rod for the cradle joint.

Among the French exhibits, however, there were two equatorial mountings of exceptional beauty and of every appearance of accurate construction. These were exhibited, together with a large number of telescopes mounted in familiar styles, by Bardou. Both were provided with driving clocks, or perhaps more properly by substitutes for driving clocks, the smaller having a fan without any obvious isochronous element and the larger a friction control. Each telescope was mounted upon a hollow iron pier of attractive design, and was furnished with circles having their divisions and numbers in white on a black ground, a feature which would appear as well adapted to convenience in reading as it was to effective finish. A commendable feature in the larger of the two telescopes was a second smaller declination circle near the tube, divided to degrees only, but so boldly that they could be readily seen from the eye end, to which the declination clamp and slow motion were brought. The hour circle in both was at the head of the polar axis, and the divisions upon a conical surface, admitting of convenient reading. The steel axes, well designed as regards length and weight, were of a very handsome dark finish. The slow motion in right ascension was of an efficient design. The driving clock was thrown out of action by means of a lever under the head of the polar axis. An unusually wide separation between the axes of the polar axis and the tube did not appear to recommend itself as convenient.

Besides these excellent telescopes should be noted an equatorial mounting of Secretan carrying two parallel telescopes of perhaps 4 inches aperture, one of which was corrected for photographing. It had no driving clock.

An equatorial mounting of peculiar design was a small one exhibited by Lutz, and carrying a telescope somewhat less than $2\frac{1}{2}$ inches aperture. It was constructed for a comet seeker. The convenient position of the declination arc and hour circle, together with small extent of motion of the ocular during observation, are apparent from the figure (a). The counterpoise at the lower end of the polar axis is to balance the motion about the latitude adjustment, which may or may not be changed during a lifetime.

Of exhibitors in this field other than French, only England was represented. Dallmeyer exhibited a large photographic telescope with an attached finder of about $3\frac{1}{4}$ inches aperture, mounted very elaborately. It was described as practically the same as that employed by Dr. Gill at the Cape of Good Hope for his stellar chart.

Besides this instrument, was noted a portable equatorial of $3\frac{1}{2}$ inches aperture, with unusually short axis. In the same case was a pretty little terrestrial telescope, mounted with a far better joint than the almost universal cradle joint, since the tube may retain its center of gravity unchanged with respect to both axes of rotation, whatever its direction. The figure (b) makes clear its construction.

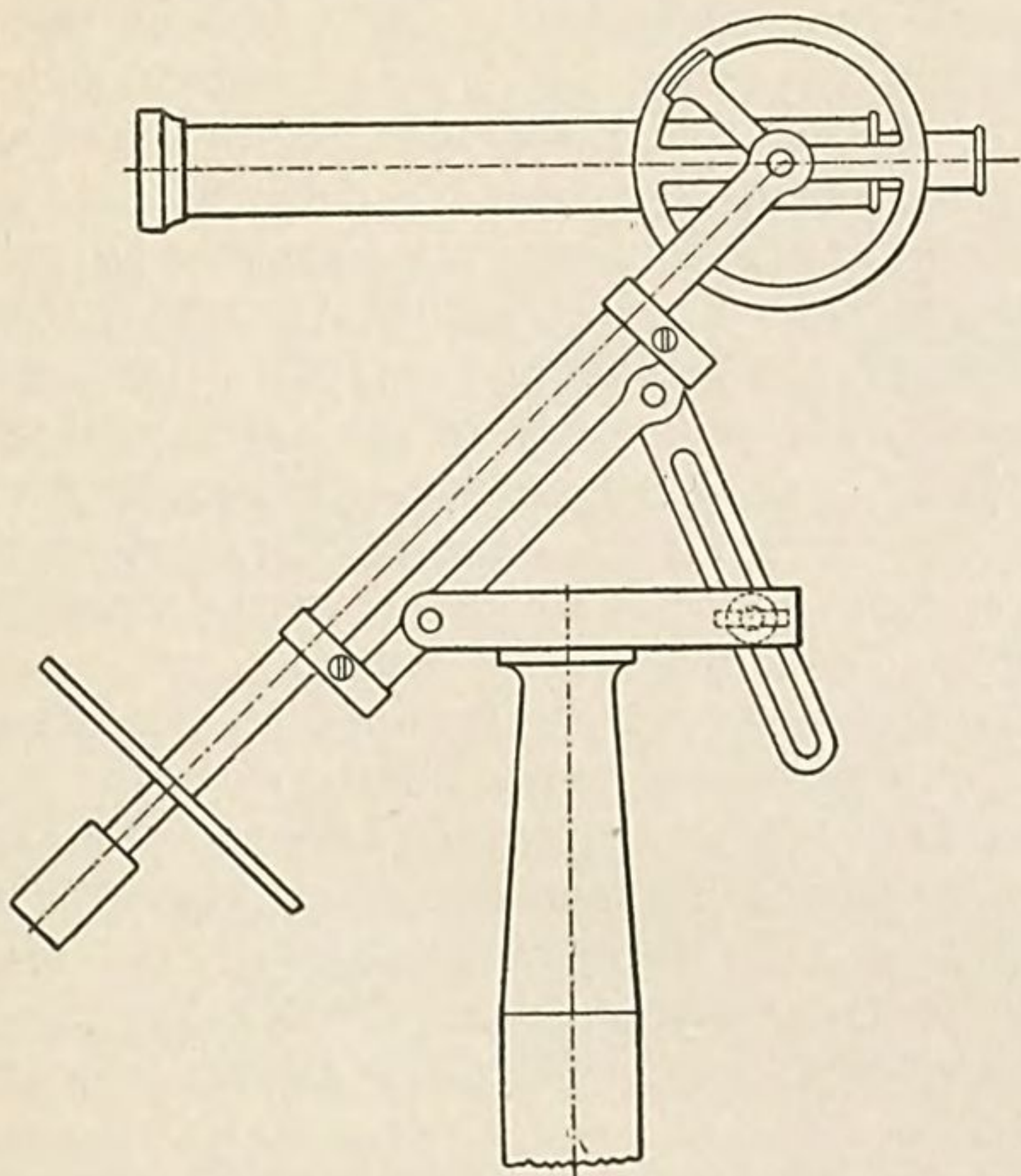


FIG. a.

The London optician, Pillischer, exhibited a highly finished portable equatorial mounting carrying a telescope of about 3 inches aperture, closely resembling Cooke's model. Like this model the circles were graduated on the cylindrical surfaces and left bright, at the same time the dividing is carried to the most impracticable minuteness.

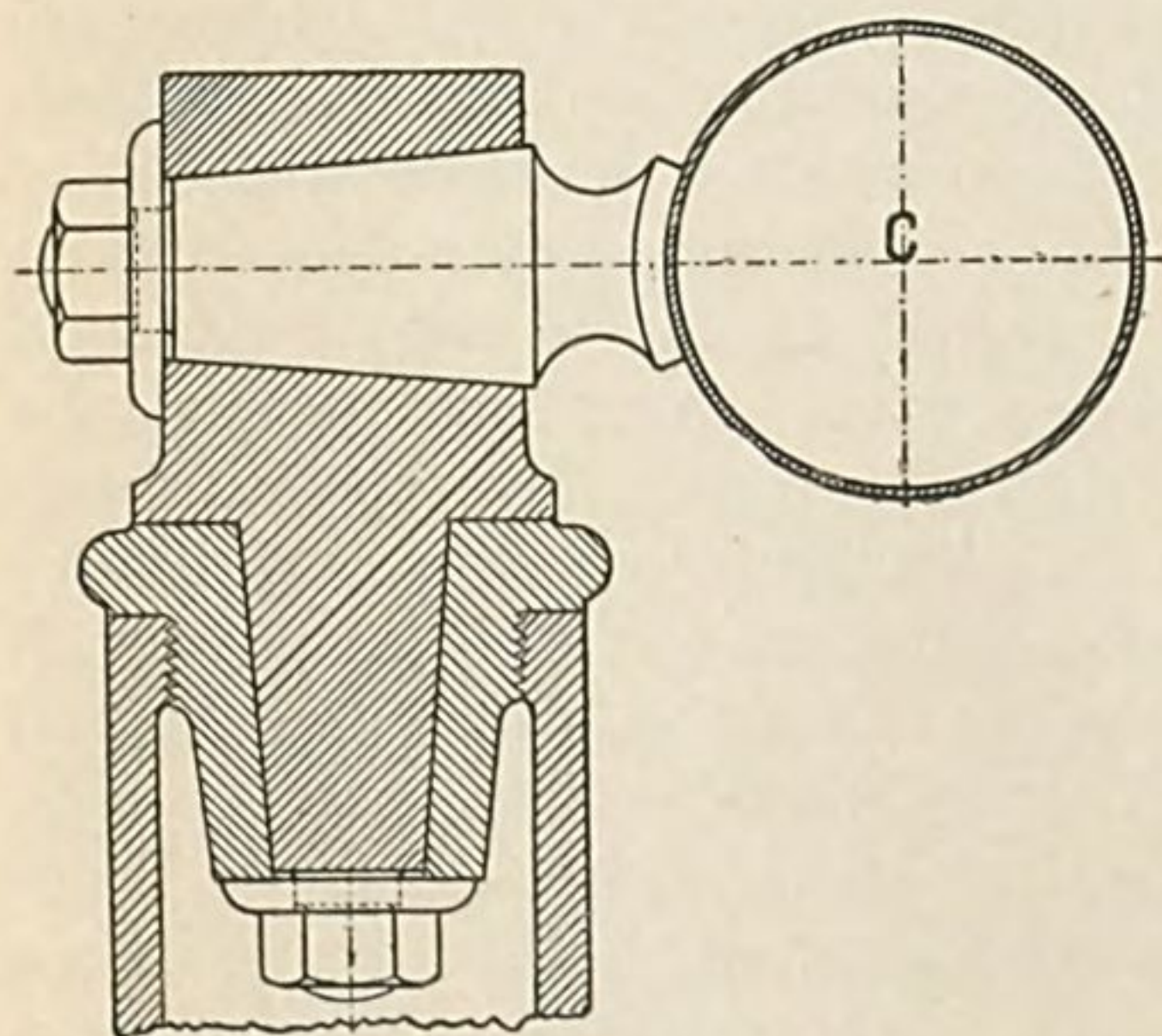


FIG. b.

A small telescope exhibited by the Maison Prazmowski is worth noting, as the only example of a tendency which reappears so often,

namely, an effort to shorten the focus as much as possible. This instrument was estimated to have an aperture of not far from $2\frac{1}{4}$ inches, and a length of 14 or 15. It may, not improbably, considering its origin, be a triumph of the optician's skill, but it certainly can not be as good as an equally well-made telescope of twice the length.

It was somewhat surprising not to find reflecting telescopes, that is, the modern silver-on-glass type, better represented in the Exhibition, in view of the fact that it was invented in Paris, and that it is supposed to be peculiarly the amateur's construction. Only Secretan and Lutz exhibited specimens; the former, a silvered mirror of 9.9 inches diameter, and a focal length ten times as great, figured by the Brothers Henry, and two telescopes with primitive altazimuth mountings, one having an aperture of 6.3 inches, and the other half this size; the latter a similar mounting with an apparently unusually short tube for the aperture. The suggestion that this type of telescope has become nearly as unattractive to the amateur as it has to the professional astronomer is obvious.

Of telescopes attached to circles for angular measures of extreme accuracy, the only examples which seem to call for notice were a beautiful altazimuth instrument with a telescope of 4.25 inches aperture and a very remarkable meridian circle having a telescope of 8.7 inches aperture. The former, constructed for the Observatory of Besançon, was contained in the case which protected the Henry objectives described above. Each of its circles was read by four microscopes.

The latter of the two astronomical instruments named above may be justly regarded as the most notable purely scientific apparatus of the Exhibition. Constructed for the Argentine Republic by Gautier (whose instruments may be found in almost all countries except Germany, England, and the United States, where German makers are perhaps best known), it is not more remarkable for its great size than for the beauty of its finish and the perfection of its details. Very great novelties in the fundamental construction of an instrument which has been for nearly two hundred years the main reliance of exact astronomy can not now be expected; thus, here, it is only by studying details of construction, which could have special interest only for the professional astronomer, that any marked originality is obvious. The method of illuminating the circle for reading with the microscopes, however, is peculiar to Gautier's instruments, and is well worth describing. Just beyond the ends of the axis, on both sides, is a system of six plane mirrors of considerable size. These are so arranged, tangent to a cone coaxial with the pivots, that a portion of the incident light from a lamp or gas jet placed about 4 metres from the end of the axis is reflected radially outward towards each one of six reading microscopes attached to the piers; this

light so reflected is deflected by a mirror in front of the objective of the reading microscope, so as to fall nearly in the direction of the lines of the graduated circle. The value of such care in providing for a rigidly constant system of illumination in all circles where the extreme of precision is required is known to all observers. The mechanism for reversing so formidable a transit instrument was not exhibited.

MICROSCOPES.

The most recent advance in the construction of the microscopic objective, namely, Professor Abbe's apochromatic construction, was represented by a single exhibitor only, Reichert, of Vienna. It is well known to microscopists that Powell and Leland in England have also had some success in cultivating this new field of optical refinement, and that Spencer in this country, without making use of the optical principles discovered by Abbe, and so successfully applied by Zeiss, has succeeded in making objectives which are close rivals in power of the famous Jena productions. Notwithstanding that only one of these four leading makers was represented, the exhibition was far from lacking in interest. The present ultimate reach of the microscope in defining minute objects was well illustrated by a photograph of *Amphipectura pellucida* exhibited by Reichert in conjunction with his microscopes, and by a very extraordinary album of microphotographs of diatoms, exhibited by Mr. Léon Duchesne. Mr. Duchesne's work was accomplished with a Zeiss apochromatic of 1.40 aperture, and is perhaps of unrivaled excellence; hence it serves to mark the limit of the art of microscope making at the epoch of the Exhibition in a most interesting way. There were many other microphotographs scattered through the Exhibition, but they served for the most part either to illustrate some new photographic process, or some new application of the photographic method, and are consequently of less interest in reference to the present review.

With the exception of Reichert, the exhibits were confined to French and English manufacturers. Of the English exhibitors, Ross & Co., Watson & Sons, and Pillischer all had extensive exhibits. Perhaps the most significant general conclusion to be drawn from an inspection of the instruments displayed, is that, notwithstanding the vigor with which the English model with its long tube is defended, the advantages of the German and French forms are such that most of the makers are compelled to make concessions to a growing demand for them. Only for binocular microscopes does the long tube offer any advantages whatever, and one of the makers named above showed a microscope of this class with short tubes. The vogue of the admirable Abbe illuminator was clearly indicated here, as well as among the French microscopes.

The very extensive collection of mounted microscopic objects shown by Watson & Sons may be properly noted here. Many of them were of extraordinary beauty, and, disregarding the question of scientific propriety, tasteful in arrangement. Besides these, excepting several collections used for the purpose of illustration, only Miss Booth, of Longmeadow, Massachusetts, entered a general collection. These slides, though wanting in the meretricious splendor which may be secured by a proper combination of diatoms and butterflies' scales, had the delicacy of finish and cleanliness in the objects mounted which are familiar characteristics of work from that source.

Of the French manufacturers one would expect the exhibitions of Nachet (J. A) and of the successors of Prazmowski (Bézu-Hausser & Cie.) to be notable ones. The latter firm exhibited about thirty-five objectives of all powers, together with many stands of good design, but of conventional types. In the gallery devoted to photographs and photographic apparatus they showed a good camera for microphotography.

The large collection of instruments exhibited by Nachet included a very neat hand microscope for class demonstration and the curious old inverted "chemical" microscope with its colossal tube and incredibly large lenses. This instrument, finished with a taste and elegance peculiar to the French opticians, is a most singular anachronism. Of the considerable number of microscopes in the same case, those designed for mineralogical and petrological work might be specially distinguished for unusual excellence in design and finish. Two pieces of apparatus for microphotography should not pass unnoticed; one of them was very large, well constructed, and complete in its details; the other was vertical, that is, the sensitive plate was held in horizontal position above the microscope and provided with a supplementary eye tube, so that an exposure may be made whenever the conditions are regarded as satisfactory by the observer. The tube at the side of the camera, provided with a right-angled prism and small Galilean telescope, would doubtless prove a great convenience in focussing the camera, for which purpose it is intended.

Other exhibitions of interest were those of Verick & Stiassnié, including a number of well-designed microscopes, an Abbe illuminator with iris diaphragm, and a large camera for microphotography; and one of Moreau-Teigne, which, however, contained chiefly telescopes and spyglasses.

MISCELLANEOUS OPTICAL APPARATUS.

Under this head is included the very extensive class of apparatus which is employed for scientific purposes, and which is represented more or less completely in every collection of physical apparatus in

the world. It embraces, then, nearly everything which would appear in the catalogues of opticians under the name optical apparatus, excepting the classes already described, together with cameras, opera glasses, and spyglasses, reading lenses and spectacles, and illuminating apparatus employed in light-houses and in military and naval operations.

The wonderful activity in the domain of physical optics, during the middle half of the present century, of the French physicists, including Malus, Fresnel, Arago, Biot, Foucault, and others, together with the skill of such able opticians as Soleil, Hartnack, Duboscq, Prazmowski, Lerebours, and their successors, has rendered Paris the chief center of this branch of the opticians' art. Such, however, is the great variety of objects and of apparatus included by this definition, that a logical classification would be difficult and perhaps useless. It seems better, then, to review the exhibition by considering the objects as presented by the various manufacturers, more particularly as such a procedure would probably serve as a better guide for the reader.

Maison Jules Duboscq, Ph. Pellin. This manufacturer is the successor in direct line of the older Soleil, who established the business in 1819. The exhibit made by Mr. Pellin was a very extensive and interesting one, far too extensive to be described in detail. We will therefore only note particularly apparatus of recent invention or of exceptional interest on other accounts. Among several heliostats was one of the Foucault type of large size, and artistic both in design and finish. A Becquerel phorphorscope, the large model, with wheel-work having helicoidal teeth, was a prominent and beautiful piece of apparatus. An unusual reading telescope, with an objective of about 3 inches in diameter and a filar micrometer, would seem more of a luxury than a necessity in physical laboratories. In these pieces of apparatus, however, though notable for their beauty and expensive construction, there were no novel features of moment. Only in the instrumental aids to photometric determinations, of which there were a considerable number, was there an obvious recent activity in invention. Besides the traditional forms of Rumford, Bunsen, and Wheatstone, were the recent photometer of Cornu (described in 1881) and that of Mascart, of which the description had been published by its inventor hardly a year before the opening of the Exhibition. The last-named instrument, notwithstanding its extreme simplicity from a theoretical standpoint, is interesting on account of its skillful adaptation to the end in view—namely, to measure the distribution of light in an illuminated hall. The diagram will make the construction clear:

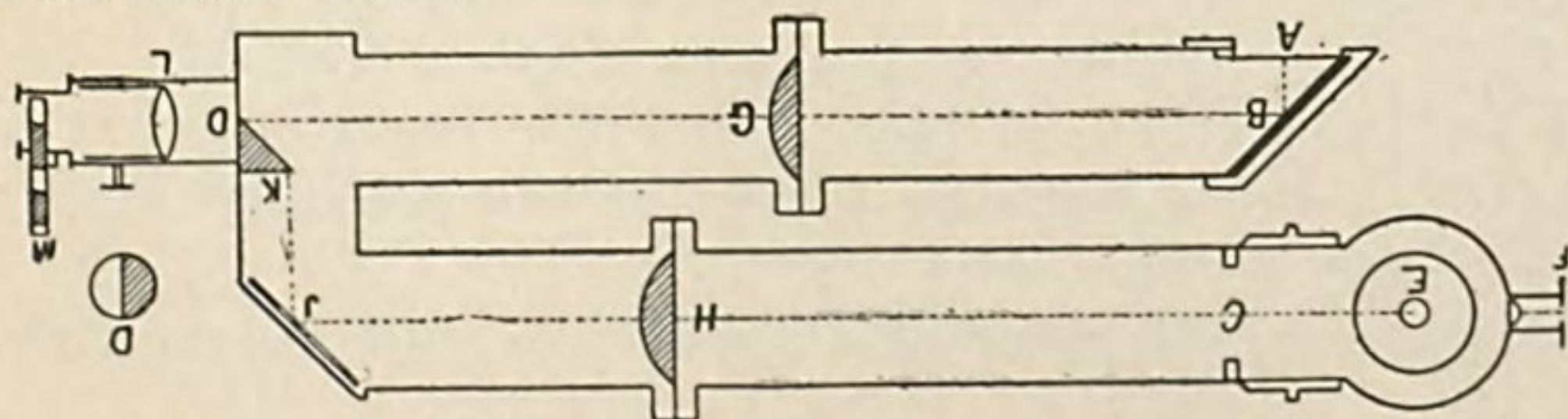


FIG. c.

At C is a screen of ground glass illuminated by a small lamp at E. An image of this screen is formed by the lens H, after two reflections at right angles by the mirror J, and the total reflecting prism K, on the surface of a second screen of ground glass D. A third translucent screen at A, which is to be illuminated by external light only, has its image, after reflection by the mirror B, formed upon the other half of D by the lens G. These two lenses are provided with diaphragms of rectangular apertures, which can be varied at will. It is, therefore, always possible to make the two halves of the screen D appear of the same intensity as seen through the ocular L, and the quantity of light transmitted through the two lenses will be in direct ratio with the areas of their restricted apertures. By comparison with a standard light, the measures made with this instrument can be reduced to the customary photometric scale.

Besides the very large collection of complete physical apparatus, Pellin exhibited a collection of crystal sections, including many which were rare and curious, a number of large Nicol prisms, and a set of Professor Rowland's beautiful gratings.

Albert Duboscq, another scion of the famous house of Soleil, presented a collection of physical apparatus, chiefly optical, which was also of great excellence. The projection apparatus, in general construction similar to that which bears his family name, and which is so widely and favorably known in this country, shows some modifications in details which must be looked upon as improvements. A large lantern with vertical attachment, for use in physical lectures, and a fine silenium cell, are especially worthy of mention among his collection.

Léon Laurent is not less well known to recent purchasers of physical apparatus than Duboscq, and his exhibit of instruments of precision was no less remarkable in its completeness and general excellence than those of the makers previously mentioned. The most characteristic features of the collection were the variety of saccharimeters, that instrument which is so interesting in its history, so creditable to both French opticians and physicists, and which Laurent himself has done so much to improve; and a system of tools for testing the constants of prisms and lenses during construction. These tools consisted of focometers, which were distinguished from the familiar types in having the linear scales vertical instead of horizontal, and in measuring from one side of the lens by means of a collimating ocular and a plane mirror of black glass; of apparatus for readily applying the test of Newton's rings as formed between the surface under investigation and fiducial standard surfaces, together with the standard planes, and of a variety of goniometers with large prisms to serve as types for the principal angles used in optical work.

Besides these were quartz spheres made for standard weights, large

Thollon prisms for spectroscopic purposes, and admirable specimens of the new "tempered" glass, in which the strains were so pronounced that, although the cylinder or prism was terminated by plane and parallel sides, the piece, as a whole, acts as an irregular concave lens, and refraction through a portion near one side shows remarkably strong double refraction. The conditions for securing such effects are said to be extremely critical.

Victor Lefèbvre. A notable collection of projection apparatus, polarization apparatus, and a variety of saccharimeters.

E. Lutz exhibited many pieces of optical apparatus for use in lecture demonstrations, not differing in models from those before referred to.

A. Picart, besides an extensive display of optical articles of familiar kinds, exhibited a number of goniometers. Of these, two, one of which was very large, were of the Wollaston type, and provided with collimators on separate stands, which were quite as large as the instruments themselves. It is not easy to see that these would possess any practical qualities which would justify so exaggerated a departure from the limits indicated by theory.

Benoist & Berthiot showed a large collection of unmounted lenses, both spherical and cylindrical; many silvered mirrors; and a remarkably large specimen of very white and homogeneous quartz crystal, unworked.

Th. Simon: Another remarkable collection of unmounted lenses, prisms, mirrors, etc. The most notable single article was an "aplanatic mirror" of glass, silvered on the back, of 39.4 inches diameter and 38.6 inches focal length, designed to use either as a burning mirror or for a "search-light" apparatus.

Ivan Werlein exhibited an extraordinary collection of small optical goods, arranged with such taste as to give the effect of a collection of gems. Besides a large number of handsomely finished prisms and lenses, some of them offering special technical difficulties in construction, were specimens of unannealed glass, uranium glass in diverse forms, Nicols, tourmalines, and a large number of crystal sections for the polariscope. That portion of the collection designed for mineralogists and the teaching of mineralogy, should not pass unnoted; besides crystallographic models in glass in exquisite workmanship, there were many rock sections, of which one enormous one of granite must be looked upon as an interesting example of technical skill rather than of scientific interest.

An instrument worth noting was that exhibited by Mr. Margier for determining the foci and axial optical constants of small optical systems, such as microscope objectives. The fundamental principle of the apparatus may be thus stated: If the image of an object upon a screen is the same size as the object, then, in order to double the size of the image it is necessary to increase the distance of the lens system

by its own focal length from the screen, and the object by half this distance. The instrument is very ingeniously arranged to make this determination with a minimum of manipulation. The ingenuity expended in instruments of this class is almost enough to make one regret that an accurate determination of the axial constants of any optical system is of the least moment in the theory of the instrument of which it is a part.

INDUSTRIAL OPTICS.

The meaning of this term has already been defined under the last head of miscellaneous apparatus. The exhibition does not admit of such minute analysis in this department as in the others, which becomes obvious when we consider the simplicity of the objects involved. One spectacle lens is much like another; a new type of an instrument made in such enormous numbers as are opera glasses in Paris, can only maintain itself against imitation by excessive badness of design, in which case it has no interest for the reader, or by exceptional beauty or cost in ornamentation, when its consideration belongs in the report upon jewelry rather than in optics. Originality in the fundamental lines of construction of either of these pieces of apparatus, or in that of the pocket spyglass, can hardly be expected; nor, when we reflect upon the eagerness with which a promising novelty in any apparatus or utensil, which is manufactured and sold by the millions, is pushed in commerce, can we expect that a happy chance had led to a discovery just long enough before the opening of the Exposition to admit of its being perfected, and at the same time to forbid its having been exposed for sale in every city in Christendom. For these reasons we shall only indicate in a general way the features which were characteristic of the exhibition.

E. J. Radiguet, a manufacturer at Evreux, exhibited a large collection of flat glasses and mirrors, white, colored, and black, for use in sextants and other optical apparatus. This exhibition was a remarkable example of specialized manufacturing, for not a curved surface was to be found, and the prices of the products were so low that successful competition would seem almost hopeless on any other plan.

The Société des Lunetiers presented an attractive exhibit of lenses and mirrors, especially rich in spectacle lenses of colored glasses, and those of unusual curvatures.

One exhibitor showed achromatic spectacles and eyeglasses. These, though not new (the same manufacturer exhibited them at the Philadelphia Exhibition), are interesting examples of hyper-refinement in improvement of common instruments. There was, however, much other apparatus exhibited by the same manufacturer, which seemed to be of a high degree of excellence.

Of opera and field glasses there were innumerable examples.

Manufacturers whose Exhibitions were of special interest were Baille-Lemaire, possibly the most extensive manufacturer in the world in this field ; Bardou, a very large number of opera and field glasses, together with telemeters ; Bourdon, whose novelty of a graduated focusing rod seems to be more promising of occasional utility than the innovation of having the tubes carrying the objectives move with respect to the hand instead of the oculars, and which is stated to give a larger field ; Colmont, whose pretty exhibit suggested that mounting in mother-of-pearl was a specialty ; Fréchet, with an apparently convenient handle for opera glasses ; Levy, exhibitor of some of the most beautiful opera glasses in respect to ornamentation which could be found, and whose opera glasses in gilt aluminum were of striking elegance of design, and a host of others.

The number of opera and field glasses mounted in aluminum was suggestive of the popular demand for them, but the cost of such instruments has not greatly changed during the last fifteen years, notwithstanding the enormous increase in the use of the metal and its vastly increased production. The explanation given the writer by a manufacturer was, that although the price of aluminum had largely decreased during the last few years, this did not hold true for the quality which was necessary for drawing into tubes and spinning, such as must be used in these instruments. If this is a correct explanation we may expect a material decrease in the cost of these luxuries in the immediate future, judging from the success attending the present production of aluminum in this country.

Of the many collections in the Palais des Arts Libéraux illustrative of the history of development of various arts, not the least in interest was that exhibiting the improvements made during the present century in illuminating apparatus for light-houses and other marine signals. As is universally known the improvement has been, in general terms, the substitution of lenses as a means of economizing light for mirrors, or, in the language of the older writers, the displacement of catoptric methods by dioptric ones. The problems presented in this work are by no means simple ones, and of Fresnel's many claims to fame the general solution of these is one of the greatest. The problem in its baldest outline is this: Given a source of light, how shall we direct the greatest amount of it in a horizontal direction, so that it can be seen from the greatest distance. But when we add the limiting conditions, that of all the lights on any one coast no two shall so far resemble each other that they can not be certainly distinguished in a few seconds; that there may be one or many arcs of the horizon of large or small angular extent where light is not desired; that whatever the luminous source, there is a physical limit to its brightness, and in order to secure more light it is consequently necessary to increase its magnitude; and, finally,

that we are practically restricted to plain, spherical, and circular cylindrical surfaces in the lenses, it will require little thought to make clear the extraordinarily complex character of the problem in its practical applications. When Fresnel turned his thoughts to the subject, lenses of large angular aperture, that is, lenses which would deflect in the desired direction any considerable portion of the light emitted by the source, were necessarily lenses of great thickness. But a thick lens is quite impracticable, not only on account of the technical difficulties in making it, but also on account of its opacity. Fresnel's capital invention was a means of avoiding this difficulty by making the lens of pieces ground and polished separately, and then cemented together in concentric zones; by this means he not only reduced the thickness, but also escaped, to a large degree, the defect incident to the use of spherical surfaces, since the different zones may be bounded by surfaces of different curvatures. For light which left the source in a direction too greatly inclined to the desired direction to admit of deflection by refraction alone, this eminent physicist used curved prismoidal pieces of glass which combined refraction at two surfaces with total reflection at a third so as to accomplish the result with admirable precision. But lanterns made of such lenses as these would have to be of enormous size in order to be effective with flames of as feeble luminous intensity as those at command in the early part of this century, therefore the improvement in lights for signals was inseparably bound up with the improvement of lamps, so as to greatly increase their intrinsic brightness. In this improvement Fresnel is associated with Arago. By burning oil from wicks in the form of concentric cylinders with a strong draft, and a mechanical means for keeping the burners sufficiently cool, the foundation was laid for a development of this art which can only be hinted at here. The Exhibition showed, however, an almost complete series to illustrate this development, from the first polizonal lens of Fresnel, where the limits of the zones were polygons on account of unsurmounted technical difficulties in construction, through the type, long used, where the zones were circular, but made up of short sectors, to the current type of construction where the zones are unbroken rings. A parallel series could be traced for those forms used for fixed lights where the surfaces of the refracting system are described by a system of circular arcs rotated about the *axis* of the lamp flame instead of about a line at right angles to this axis. In other portions of the Exhibition could be found examples of those modern forms, of which the chief characteristics might be described as, first, a replacing of metal mirrors on the sides toward the directions whither light is not required by systems of totally reflecting prismoids, and, secondly, by complexities introduced solely for the purpose of giving individuality to the signals. The very limit of this long course of evolution could be

seen in a building on the park of the Trocadero, which contained a magnificent rotating lantern, destined for a light-house on the lower Seine, made by F. Barbier & Cie. This marvelous structure of polished glass was nearly 105 inches in diameter. By its side was the lamp to be employed in it, having ten concentric wicks, showing a bold advance over the lamps of four concentric wicks which were twenty years ago employed for lights of the first order.

In several portions of the Exhibition were those forms of illuminating apparatus which have recently become familiar under the name of "search lights," especially in the Hall of Machinery and on the top of the great tower. The optical problems involved in their construction are far simpler than those of the light-house, not only on account of the emitted light being required in a single direction, but also on account of the minuteness of the luminous surface in an electric light. Their high efficiency was manifest to the many millions of people who saw the sharply defined limits of the beams of light from the top of the tower.

OPTICAL GLASSES.

Mr. Mantois is successor to Feil & Mantois, and thus the direct successor in a historical sense to that Swiss watchmaker, Guinand, who first succeeded in furnishing optical glasses of the purity and properties demanded by the invention of Dolland. The story of this invention is one of those romantic histories in the evolution of modern arts which seem to repeat each other in their general features. For nearly half a century there had been an eager demand for optically good flint glass, *i. e.*, dense glass containing oxide of lead, which, as far as we know even to this day, could only be satisfied by the invention of the process due to this poor mechanic. Drawn to Munich by the discerning genius of Fraunhofer, he made there a number of large disks of glass, one pair of which, in the famous equatorial of the elder Struve at Dorpat, may be regarded as the most celebrated telescope, save Galileo's, in existence. Although he remained a few years only at Munich, he left there a manufactory which, though subsidiary to one optical firm, and apparently supplying no other opticians, remained active for many years. Guarding his process as a secret whose value could only be measured by the labor and sacrifice it had cost him, he died, according to the legend, without imparting it to anyone. His son, however, guided by suggestions gathered at his father's house, rediscovered the process and carried it with him to Paris. His first associate there, Bontemps, afterward went to England and became the director of a department in the great glass manufactory of Chance Brothers, at Birmingham, which for many years was a rival of the Parisian house, and which furnished the materials for some of the largest modern telescopes, that at Washington being the most famous. About 1842 Guinand started, in conjunction

with his grandson, Feil, a manufactory for optical glasses, which has been in constant operation until the present time. It is a curious fact that the process, though known of all men, is still treated as a profound secret by most of those who employ it.

Mr. Mantois, who became proprietor of this famous factory upon the death of Mr. Feil in 1887, has greatly extended it and increased the amount of its product. He has also maintained the interest of the exhibition which has distinguished the house for a half a century in nearly every great fair in Europe or America.

In a certain sense the extraordinary collection of telescope objectives exhibited by the Ministère de l'Instruction Publique, which have been described above, may be regarded as a part of Mantois's exhibit, since he furnished all the material for them, and that within the very brief time of two years.

In the exquisitely beautiful collection bearing his name, in the section devoted to exhibits of glass, the most striking object was a polished crown lens of 41.3 inches in diameter. Its present weight is 288 pounds, but the original mass from which it was made, after fourteen months of alternate molding and excision of faulty proportions extended by protracted periods of annealing, was 639 pounds. But it does not require this knowledge to convince an observer, who has had experience in testing glass for telescopic purposes, that the difficulties in making a faultless disk of this size are well nigh insuperable.

Besides this notable lens were two disks of crown glass, 21.3 inches diameter, of which one is said to be made for a telescope to be erected at Denver; a pair of disks, *i. e.*, a crown and a flint, of 18.5 inches diameter; a second and a third pair of 16.2 and 13.4 inches, respectively; and a prismatic disk of flint glass, 10.6 inches in diameter, having a thickness of 2.65 inches on the thickest side, to be used for stellar spectroscopy after the manner made familiar by Secchi.

Of specimens of optical glass other than those intended for large telescopes were three remarkable prisms, polished upon the three equilateral sides, one of light crown, and the other two very dense flint glass—density 4.72, mean index of refraction about 1.77. The flint prisms, though of a strong, yellow color, seemed to be absolutely homogeneous, at least so far as ordinary tests without the use of polarized light, would show. The smaller prism was ill-shaped for spectroscopic use, being 7.9 inches high by 4 inches on a side; but the larger was of better form, being 4.3 inches in height, and 8.3 inches on the other edges. This must have weighed nearly 22 pounds. A considerable number of polished cubes of various kinds of glass, varying in dimensions from 10 to 55 pounds, all sensibly free from bubbles as well as the far more objectionable veins, completed an exhibit which would, on account of its intrinsic

beauty, have strongly appealed to the eye, even if the observer were unconscious of the almost precious nature of the material.

This exhausts the Exposition as far as fine optical glasses are concerned. But the famous plate-glass factory of St. Gobain, besides a number of plates of crown glass of an inferior quality for small lenses, and a large number of molded rings for light-house work, presented two large masses of cast glass for silvered mirrors. The smaller was strongly curved, 63 inches in diameter, and weighed 990 pounds; the larger, a flat disk, 51 inches in diameter and 1,320 pounds in weight, to be used for a silver-on-glass telescope, far excels anything which has preceded it. The writer was informed, however, by an optician whose experience in making large mirrors is probably quite equal to that of any other, and whose skill is famous, that this enormous disk would probably be found wanting in rigidity, on account of insufficient thickness. It would seem that nothing but experience could suggest such a criticism.

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METEOROLOGY AT THE PARIS EXPOSITION.

By A. LAWRENCE ROTCH.

Member of the International Jury of Awards of Class 15.

The display of scientific instruments at the Exposition of 1889 was pronounced by competent judges to be inferior to that of 1878. One reason, undoubtedly, which affected the foreign exhibits in all departments, was that none of the monarchical governments had an official representation, and the private bureaus organized in some of these countries could not offer great inducements to exhibitors. Thus Germany, as was to be expected, had no representation, while the exhibits of instruments of precision by Austria-Hungary, Italy, Belgium, and England, were meager, and gave no adequate idea of the resources of these countries. It should be noted, that although the United States had few exhibits in Class 15 (Instruments of precision), yet, on account of the excellence of some of them, she received more high awards than any other foreign country.

A difficulty in comparing objects in the same class arose from their being scattered over an immense area, either in the Palace or in the pavilions, etc., outside. The foreign exhibits of all classes were generally distributed through the Palace, but sometimes one country had exhibits in several places, which complicated the examination. The French exhibits in Class 15 were mostly assembled in the Palace of Liberal Arts, but some were in the Pavilion of the City of Paris, in the Pavilion of Public Works on the Trocadéro, and in the Ministry of War Building on the Esplanade des Invalides.

The classification was also somewhat irregular, so that, for example, instruments of precision were to be found not only in Class 15, where they belonged, but also in other classes, such as Class 62 (Electricity), and Class 8 (Organization, methods, and appliances for higher instruction). As further examples we may cite the fact that the phonograph was classed with the electrical apparatus, while optical glass was examined with window glass.

Coming now to the special subject of this report, we find that meteorological apparatus was displayed by two national governments, viz, France and the United States, by the city of Paris, and by about twenty firms and individuals. Meteorological publications,

etc., from a number of French and foreign observatories and weather services, were included in Class 8 and Class 16 (Geographical and cosmographical maps and apparatus).

In the following report the metric system has been used as the unit of the weights and measures given, but prices have been quoted in the United States currency.

I.—THE FRENCH SECTION.

The Central Meteorological Bureau of France, which depends upon the minister of Public Instruction, showed in Class 8 the instruments for direct observations used at its secondary stations. The recording instruments exhibited comprised the barographs of Rédier and Richard, the anemometer register of Hervé-Mangon, and the Richard thermograph and hygrograph. For the measurement of terrestrial magnetism and atmospheric electricity there were the portable magnetic variation instruments constructed by Carpentier, and a Mascart magnetograph and electrograph, both constructed by Pellin. A collection of climatic and other charts was also shown. A grand prize was awarded to the bureau, although its exhibition was unworthy of the oldest, and, in many respects, the best organized meteorological service in the world. As already mentioned, several of the observatories and departmental meteorological commissions which coöperate with the central bureau had on view photographs, plans, and publications.

The municipal observatory of Montsouris showed a number of instruments, few of which, however, presented any novelty. The researches which have been carried on in actinometry were illustrated by the Herschel-Arago actinometer, the thermo-electric actinometer of Désains, the Arago photometer, the vaporization radiometer of Bellani, and the radiometer of Crookes. A newer instrument is the recording actinometer of Richard Brothers, having bright and black bulbs in vacuo, which, being connected with two thermometers, trace curves the difference of whose ordinates is assumed to give, at night as well as during the day, a measure of the radiation from the sky; but this is not true with a varying wind velocity. In the combined thermograph and hygrograph constructed by Richard Brothers from the designs of Mr. Descroix, the chief of the meteorological service at Montsouris, the registration of the temperature is effected upon a roll of paper during six days, through the action of a spiral tube fixed at one end filled with alcohol, and of the humidity by a hair acting on a lever. In the anemograph and pluviograph of Demichel the speed of the register cylinders can be increased in order to study the details of squalls or heavy showers. There were various appliances for the collection and analysis of air and meteoric waters, which is a special service at the Montsouris Observatory. A gold medal was awarded to the city of Paris for this exhibit in Class 15.

To-day the graphic method is universally sought after, especially in meteorology, while at the Paris Exposition of 1867 it was just coming into notice. It has been recognized that the representation by diagrams of the various physical phenomena is the only way to study them properly, for by examining a curve given by any registering instrument it is at once seen how incomplete are the results of direct observations, since in a relatively short time the phenomena under study may vary considerably. It should be noted, however, that the complicated and costly meteorographs shown at the pre-

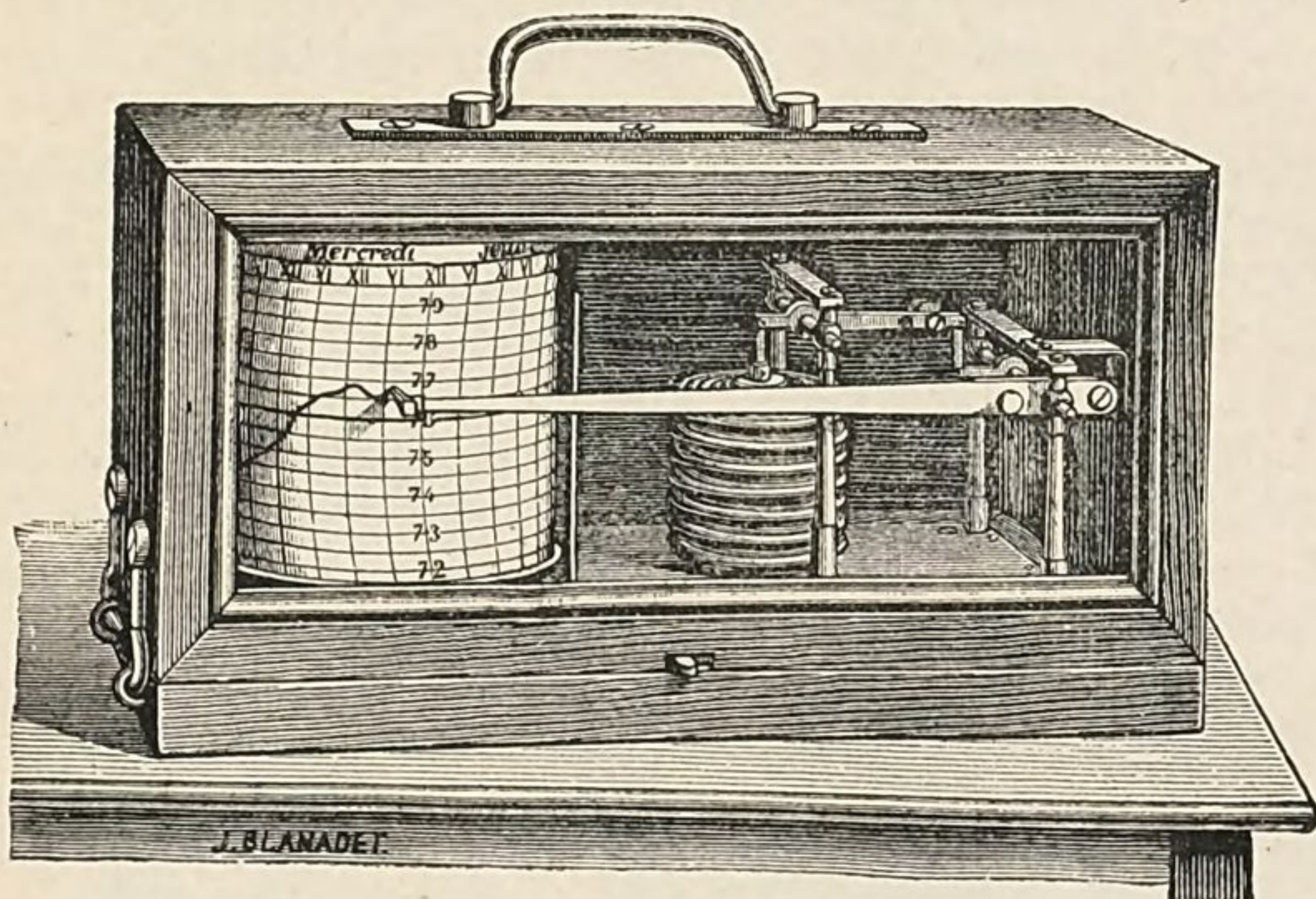


FIG. 1.

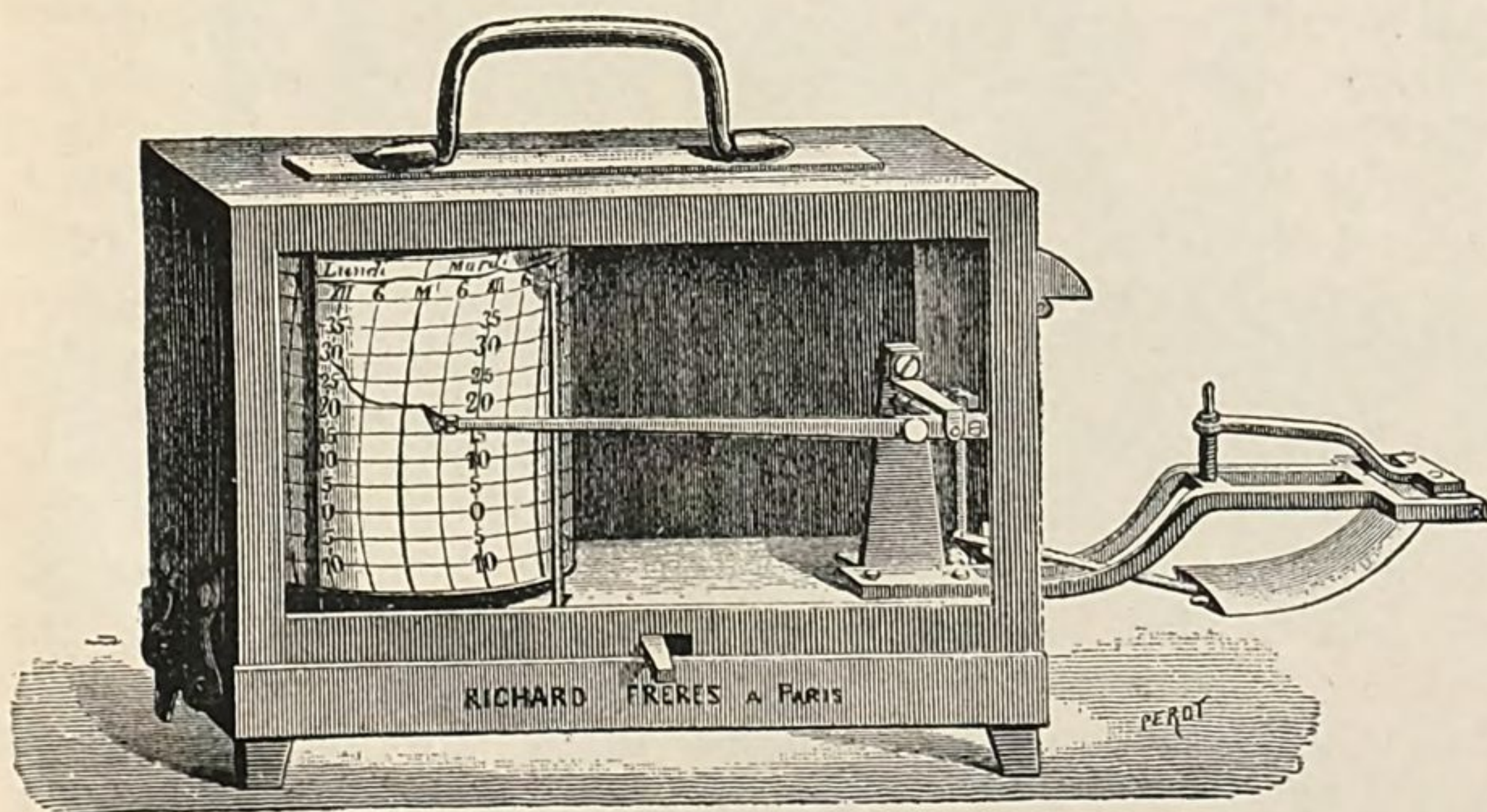


FIG. 2.

vious expositions, which registered many elements together, are being abandoned in favor of simpler and cheaper apparatus, by which each element is more accurately recorded by a distinct instrument.

From this point of view the exhibit of Richard Brothers (8 Impasse Fessart, Belleville, Paris) was the most interesting in the meteorological section. These constructors have sought to apply one simple and cheap type of register to all apparatus for control or measure. This includes a cylinder turning in function of the time by means of a clock movement inside, and a lever actuated by the instrument whose indications are to be registered. The lever carries a triangular metallic pen, which records, with almost no friction, upon a band of paper secured on the cylinder by a metallic bar. This system was the subject of a patent granted to Jules Richard in 1880, the interior elliptical balance springs in the aneroid vacuum-boxes having been patented by him in 1877.

The Richard barographs, thermographs, etc., are well known in all parts of the world, some 7,000 of them having been sold for scientific and industrial purposes. The barograph and thermograph are illustrated in Figs. 1 and 2, respectively.

Among the many new and interesting instruments shown by this firm only the most important to meteorological science can be described. In the new hygrograph a bundle of hairs, on Klinkerfuess' system, has been substituted for the slice of horn formerly employed. The hairs act at an obtuse angle upon a bell-crank lever, and by means of two cams rolling on each other their elongation or contraction are registered on the cylinder. The hairs give much greater sensitiveness than the horn, and by the new mode of transmission equal degrees of humidity are represented by nearly equal divisions on the register sheet, which was not the case before. The anemometers merit notice as embodying new principles. In the first place these constructors have discarded as a motor the Robinson cups, which possess too much inertia and an uncertain velocity of rotation as compared with the velocity of the wind, and have replaced them by a fan-wheel formed of six blades of aluminum inclined at 45 degrees and fastened to a very light axis. The diameter of the wheel is calculated so that one revolution corresponds to a metre of wind, and this relation is verified by experiment on a whirling arm and a table of corrections furnished, if necessary. The wheel is kept facing the wind by a vane with a divergent tail. Placed in the wind this fan-wheel, weighing only 150 grammes, may be compared to a feather carried by the lightest currents. The new registers of wind velocity, called cinemographs, are based on the division of the space traversed by the time occupied, which is done mechanically as follows: An endless screw working in a wheel turned by the wind carries a roller which rests on a disk. The wind's motion tends to move the roller away from the center of the disk, which, being turned at a uniform rate, tends to bring the roller to its center, and its position on the disk will correspond to the relation of the two factors, time and space, moved over by the wind.

The idea of employing a roller and disk in an integrator is not new, but the novelty consists in preventing slipping by two disks turning in opposite directions, which compress the roller by a spring. Practically the anemo-cinemograph has two clock movements, one turning the two disks by the intervention of a Foucault, or a conical pendulum regulator, the other turning freely, unless stopped by an electro-magnet connected with the anemometer which established the electric contacts. This movement carries the tangential wheel which drives the screw carrying the roller. The operation is thus effected: The disks turning in function of the time bring constantly the roller toward their axis, but the wind, allowing the other movement to run faster or slower, by means of the endless screw causes the roller to recede from the axis. When there is equilibrium between the two movements the position of the roller is momentarily

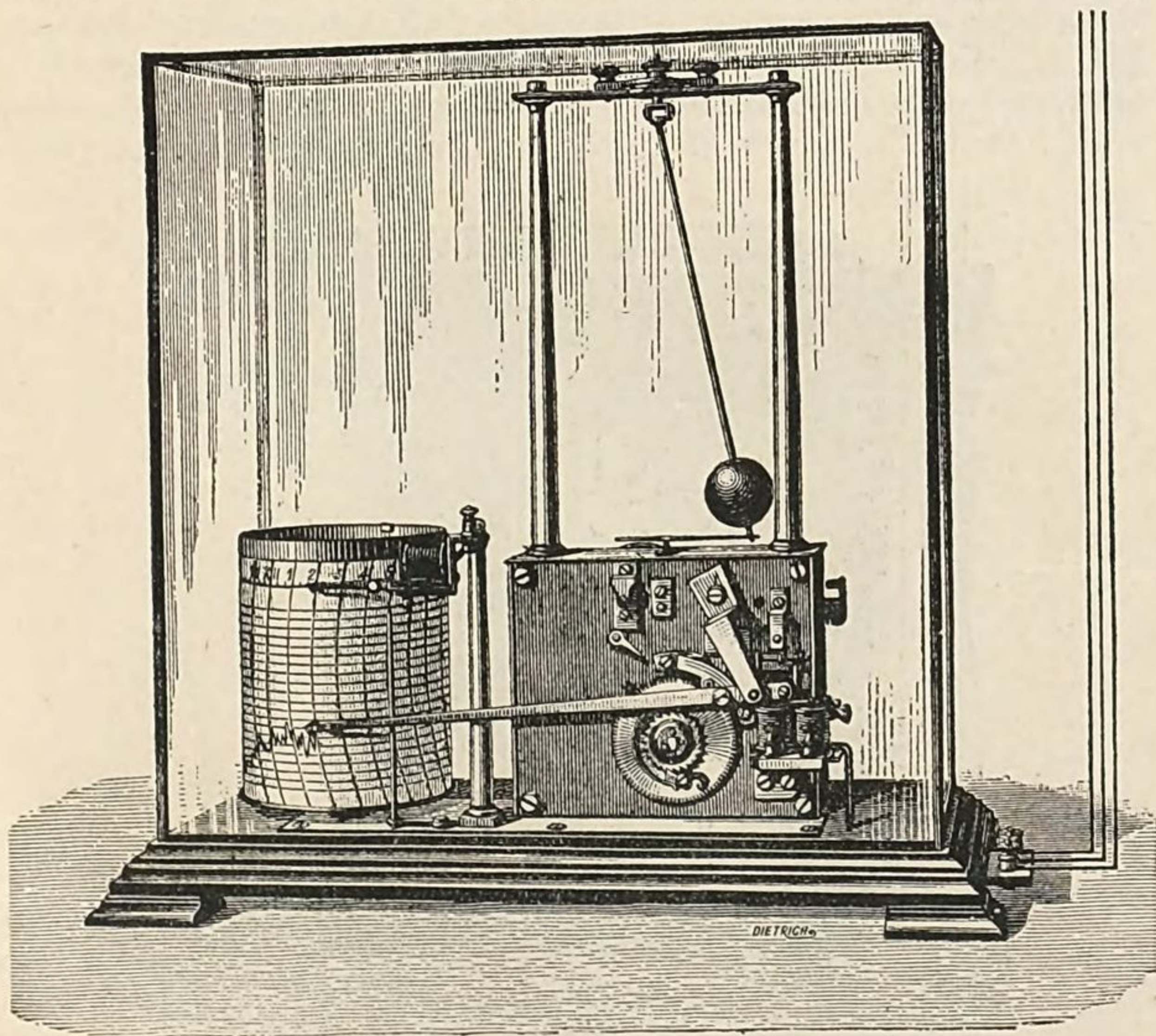


FIG. 3.

fixed and a lever attached to the screw traces by a pen the wind's velocity on a revolving cylinder. The apparatus is adapted to give the direct velocity per second, or to give the mean velocity per second by giving the disks different speeds of rotation and by changing the number of contacts. In the first case a contact is made for each 50 centimetres of wind, and to register it the speed of the

paper should be at least 3 millimetres per minute, or over 4 metres per day. In the second case a contact is made for each 50 metres of wind only, and the registering paper is contained on a cylinder turning once a day. This instrument is shown in Fig. 3. To regulate the cinemographs, a chronograph with a toothed cam breaks and makes an electric circuit just as the anemometer would do. The number of teeth on the cam can be altered so that it can be seen if the heights of the inscribed ordinates are proportional.

The anemometer which the Rev. Fr. Dechevrens first used in 1884, at Zi-Ka-Wei, China, to obtain the vertical component of the wind, was furnished with another register by Mr. Garrigou-Lagrange, and this has since been perfected by the Richard Brothers. The anemometer itself is a wheel, with vanes inclined at 45 degrees on a vertical axis, which at each revolution establishes three contacts, each being connected by a wire with the register shown in Fig. 4. This is an electric motor, with three electro-magnets symmetrically arranged around a vertical axis having a crown-wheel with four teeth. Each magnet being connected with one of the

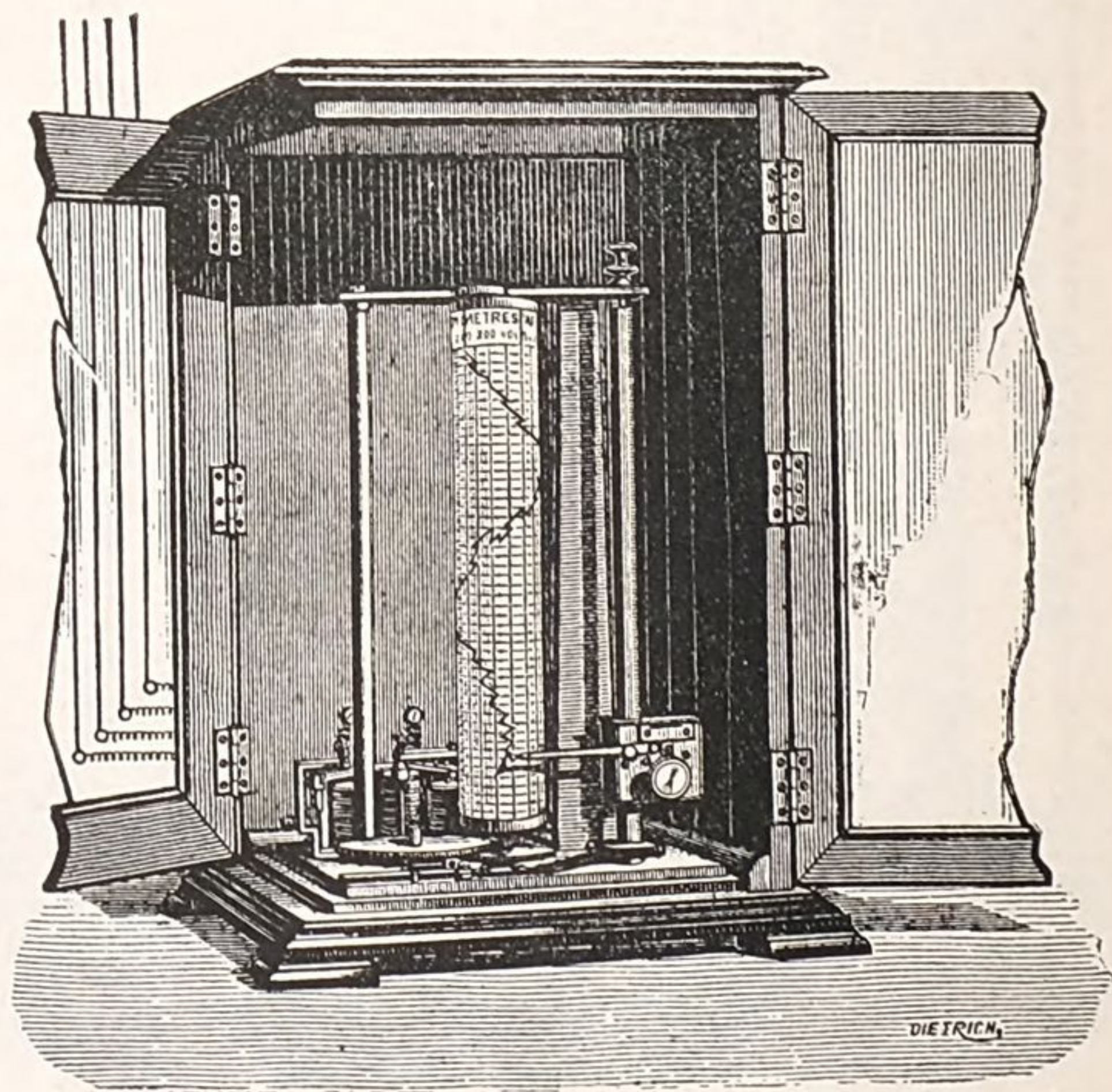


FIG. 4.

above contacts, the armatures of the three electro-magnets press on the wheel, and turn it in the direction in which the currents successively enter the magnets. A fourth electro-magnet locks the crown-wheel by engaging teeth on its under surface. In order not to exhaust the battery by continuous currents, each magnet breaks the

circuit which operated it and prepares the two others for action. When the wind-wheel turns in the direction caused by ascending currents of air the crown-wheel turns in one direction, and when the wind-wheel turns in the reverse direction which descending currents of air give it, the axis also turns in the opposite direction. These revolutions of the axis are transmitted to a vertical cylinder, which is thus displaced proportionally to the space passed over by the wind. As a pen descends on the paper covering the cylinder, diagrams are obtained in which the abscissæ give the times, the ordinates the space traversed, and the curve indicates the upward or downward movement, whose velocity is shown by the tangent of the angle which the curve makes with the horizontal.

A system for transmitting electrically to a distance the indications of any instrument has been perfected by Richard Brothers. There are three types, A, B, and C, but each has in common two posts—one, the transmitter, placed where the phenomenon is to be studied, the other, the receiver, installed where it is wished to register the variations of the said phenomenon.

In the type A, the apparatus, such as a barometer, thermometer, etc., whose indications are to be transmitted, being arranged to control

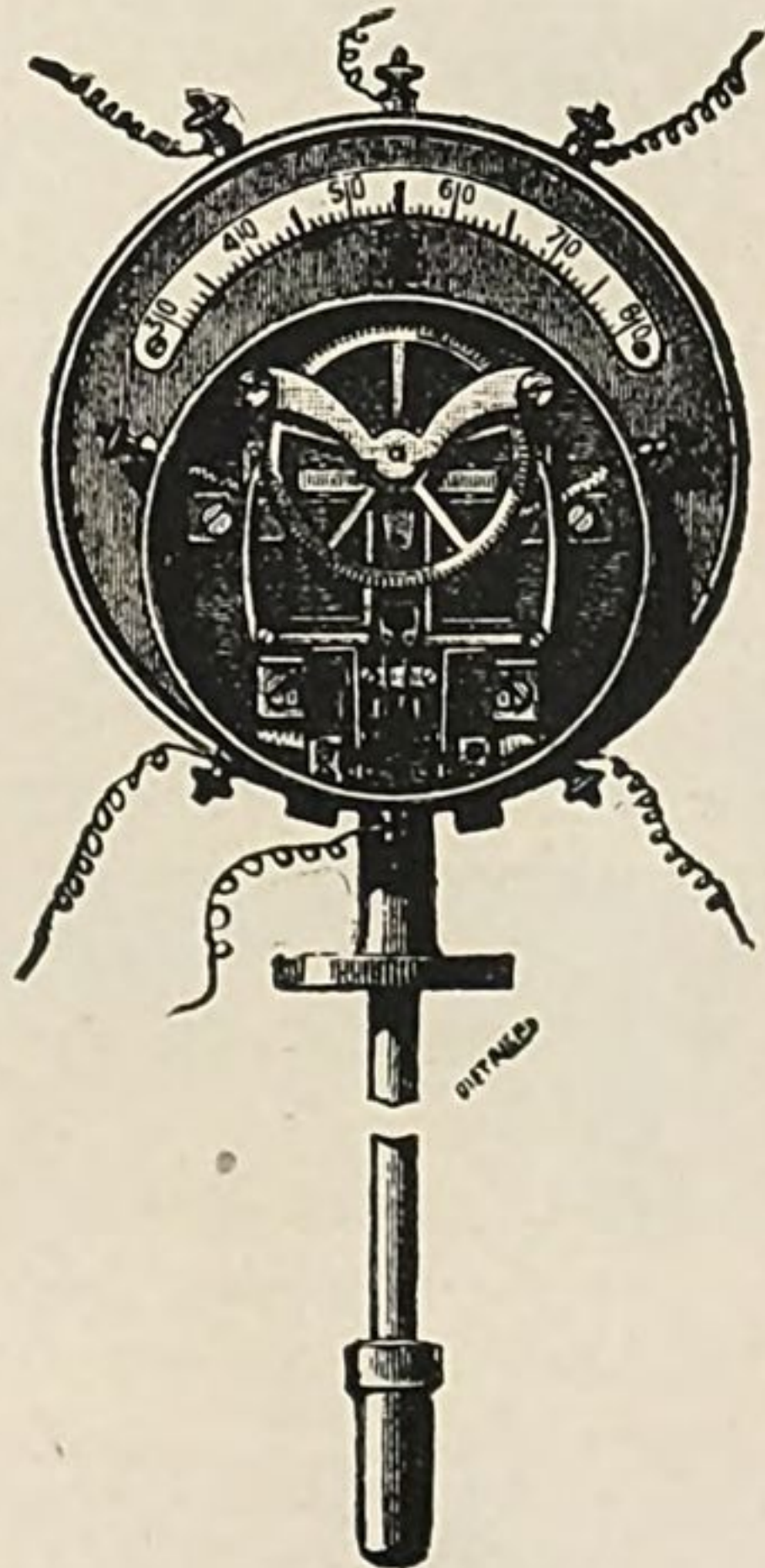


FIG. 5.

an indicator needle, the movements of the last in one direction or the other cause a mechanical motor to be put in action at the receiving post, which displaces simultaneously and parallelly a needle or a registering style. For this purpose a fork or rider is mounted

on the needle of the instrument, whose sides are insulated from each other. This rider is fixed at the extremity of a second needle placed concentrically above that of the instrument. The movements of the first are limited by the arms of the rider, which make a contact so soon as the true needle is displaced in either direction. Since the arms of the rider are insulated from each other, if they are connected separately by wires with a battery, and at the receiving post to two electro-magnets, the current will pass into one or the other of the magnets of the receiver when, at the transmitter, the needle touches either side of the rider. The transmitter is illustrated in Fig. 5. At the receiver, shown in Fig. 6, the magnets each control clockwork, and thus act on a differential train whose pinion carries the registering style. When one of the magnets is excited by the passage of the current it starts the train which it controls, and the register style is displaced by one division up or down. At the same time, when at the receiver the liberated train sets in action the differential gearing, it plunges a metallic point into a cup of mercury,

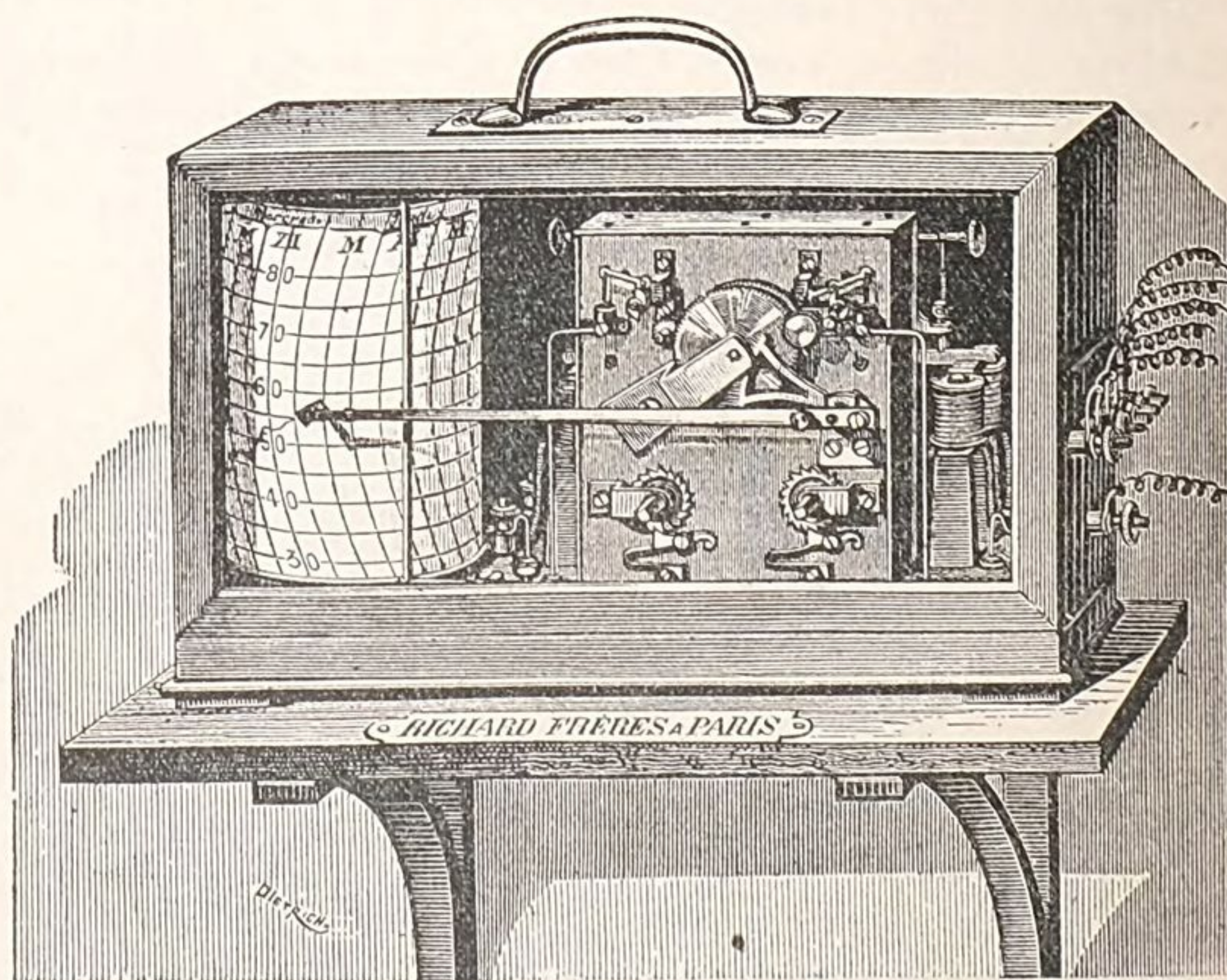


FIG. 6.

and this closes an electric circuit furnished by a second and independent battery. The current thus established returns to the transmitter and acts on an electro-magnet, whose function is to displace the needle carrying the rider, so as to put the two arms at equal distances from the principal needle. As the return current can be furnished by either train of the transmitter, there are at the transmitter two magnets bringing back the rider into one or the other position.

The apparatus is completed by an automatic break-circuit, which operates after each return of the current coming from the receiver.

It will be perceived how sure this method is, since, if at the receiver the style does not move simultaneously with the transmitter needle, the last is immediately fixed, so that if for any reason, such as the giving out of the batteries, wires, etc., the apparatus does not work, all is stopped. So soon as the normal state of things is established, the two needles move synchronously up to the instant when the transmitter needle, being at an equal distance from the two arms of the rider, sends no current in either direction. When the distance between the two stations is not great, a simple transmitter and receiver connected by six wires are used, but when the distance is considerable, and the cost of a line of six wires would be too great, the two stations are connected by only one or two wires, but the construction of the instrument is then more complicated, although on exactly the same system. Polarized armatures of a special design are used, and there is a reinforcement of the current. This arrangement of a needle placed between two branches, against one of which it touches so soon as it moves, permits the transmission of the indications of extremely sensitive instruments, since no force is required of the transmitting apparatus. Thermometers have been constructed on this system, which indicated and registered the temperature in tenths of degrees, and mercurial barometers transmitting the pressure in fifths of millimetres.

The type B is adopted when it is necessary, for example, to transmit the wind direction to a distance. The transmitter is on the same principle as that of the apparatus of Mr. Garrigou-Lagrange for the vertical component of the wind, already described. The receiver has, as before, three electro-magnets acting on a wheel with four teeth, which controls the register needle by means of a pinion and rack. In this apparatus the transmitter can send several successive currents corresponding to the same indication without changing the position of the receiver after it has registered the current sent by the transmitter.

In the type C the transmitter is composed of an insulated dial on which the divisions of temperature, pressure, etc., are metallic. The needle of the instrument moves above it, and at equal intervals of time an electro-magnet causes the end of the needle to touch the dial. This end, armed with the platinum, is in contact with one or, at the most, two divisions. With each division a wire unites a key on the receiver, where there are, therefore, the same number of divisions and keys placed in the same order as the divisions of the transmitter. In the register of a wind-vane, for example, over a sector carrying the keys, at regular intervals of time, determined by a clock movement producing automatic escapements, there moves a contact-maker attached to an electro-magnet, whose movable armature car-

ries a style. The latter moves up a cylinder turning in function of the time in the same interval that the contact-maker passes over the metallic keys of the sector. With a return wire uniting the bases of the vane and register, it will be seen that the instant the contact of the register passes over the metallic key connected with that made by the vane the circuit is closed; the magnet acts by bringing the pen on the paper, and thus marking a point on the abscissa corresponding to the metallic key and, consequently, to the momentary direction of the vane.

These various types can be applied to the transmission to a distance of all possible indications given, either by instruments having a needle, such as barometers, manometers, hygrometers, etc., or by apparatus such as wind-vanes, floats in reservoirs, etc.

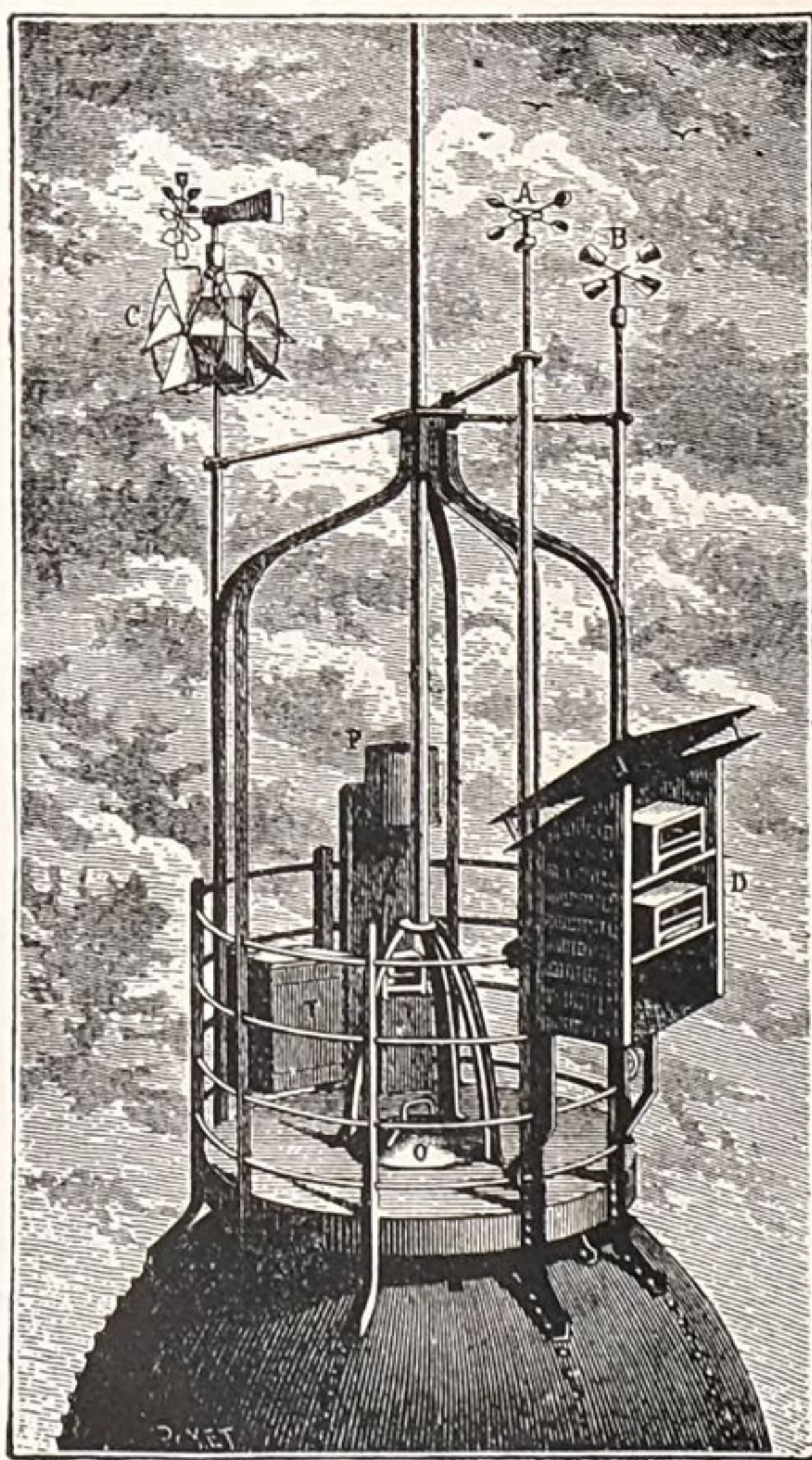


FIG. 7.

An interesting application of the Richard instruments was the equipment of a meteorological observatory with them on the summit of the Eiffel Tower, 300 metres above the Champ de Mars, of which an illustration from *La Nature* is given in Fig. 7. This observatory was furnished with the following registering instruments: a barometer, a thermometer and hygrometer contained in the shelter, D, a rain gauge, P, a Robinson anemometer, A, anemometers for the

horizontal and vertical components of the wind above C and at B, a wind-vane for its direction, C, and a thermometric transmitter. These last four instruments registered in the Palace of Liberal Arts the wind and temperature on the Tower. Similar direct registering instruments are now in use at the Central Meteorological Bureau not far distant, and to study the vertical distribution of temperature thermographs have been placed at the foot of the tower and at heights intermediate between the base and the summit.

On account of their simplicity and portability, the Richard instruments are well adapted for use in mountain or balloon ascents. Thus the registers for pressure, temperature, and humidity were carried to the summit of Mount Blanc (4,800 metres) in July, 1887, by Messrs. J. Vallot and F. M. Richard, who remained there three days. Plans were shown by the French Alpine Club, in Class 16, for a permanent observatory and refuge at the Rocher des Bosses (4,400 metres), which is to be equipped with the Richard instruments by Mr. Vallot, and opened in July, 1890. The barograph, thermograph, and hygrograph have been used by the writer in balloons.

For their collective exhibits in Class 15 a grand prize was awarded to Richard Brothers.

Although apparatus registering on the spot renders great service to science and industry in permitting the variations of the different

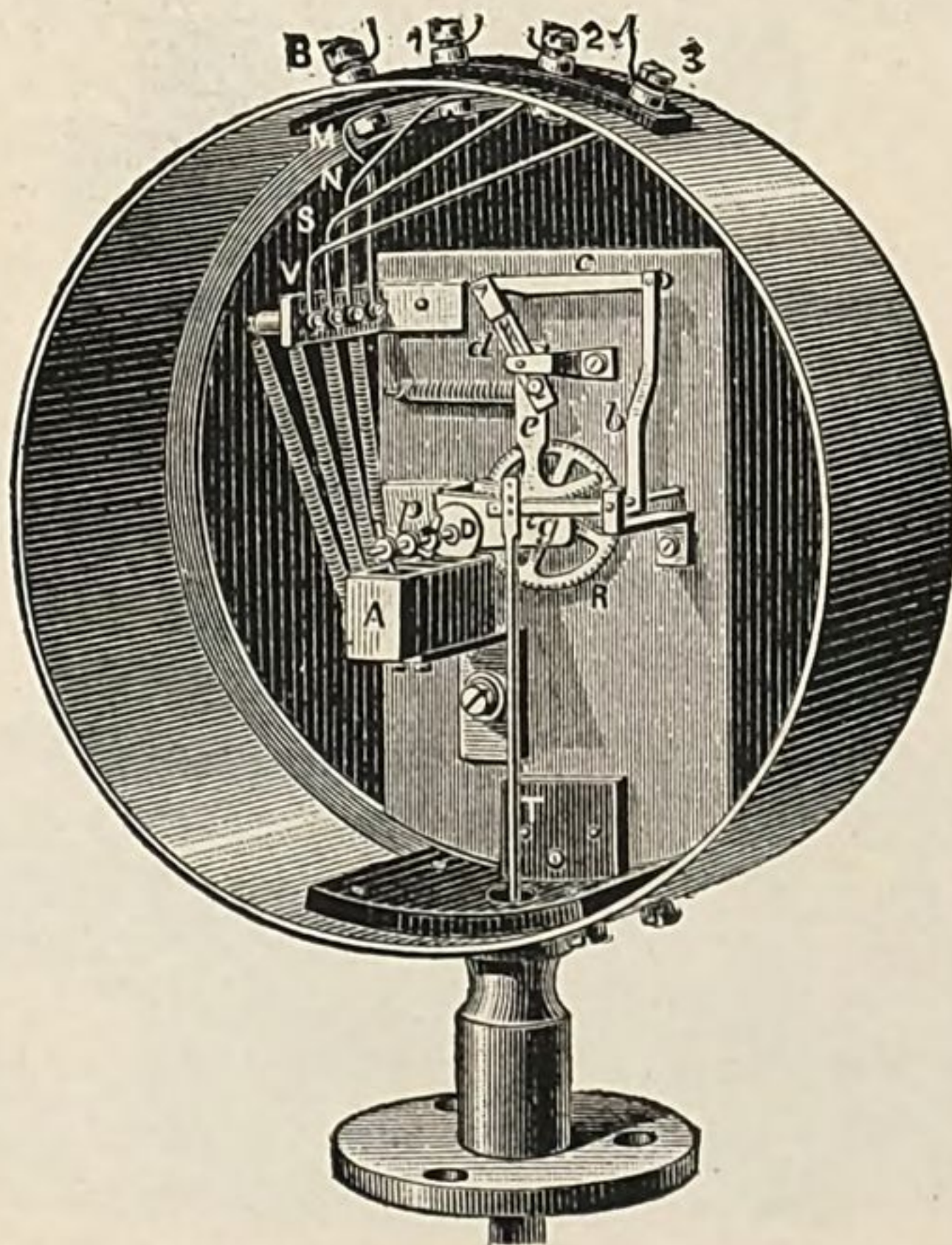


FIG. 8.

physical elements, pressure, temperature, wind direction, height of tides, and water in reservoirs, etc., to be followed, yet the need of

control at a distance, increasing with the advance of the sciences and the exactness of industrial methods, makes the retrospective data furnished by direct registration insufficient. It is necessary to devise methods of transmission to great distances of the indications of measuring apparatus, so that the scientist, the engineer, or the superintendent can collect and follow in his laboratory or office by glancing at a dial, the working of the various apparatus which interest him. This is also the object of the system of electrical transmission to a distance, shown in Class 62 by Parenthou & Co., of 18 *bis* rue Denfert Rocherau, Paris. The invention may be applied to any instrument, the object being not to impair its sensibility by requiring much force. As in the system of Richard, there are two distinct pieces of apparatus—the transmitter situated in the medium itself where the indications are collected, and the receiver placed at a distance which indicates on a dial or registers graphically. Supposing the indications of a thermometer are to be transmitted, the arrangement shown in Fig. 8 is employed, in which the thermometric rod *T*, by means of bell-crank levers, *b*, *c*, *d*, and a rack and pinion, *e g*, gives motion to a horizontal axis, *D*, having three platinum points, *p*, which, during its rotation, successively dip into cells of mercury in *A*, communicating with the battery by the wire, *M*, and the binding screw, *B*. For a complete turn of the axis there are six contacts and, consequently, six emissions of currents through the disk, *D*, and one of the

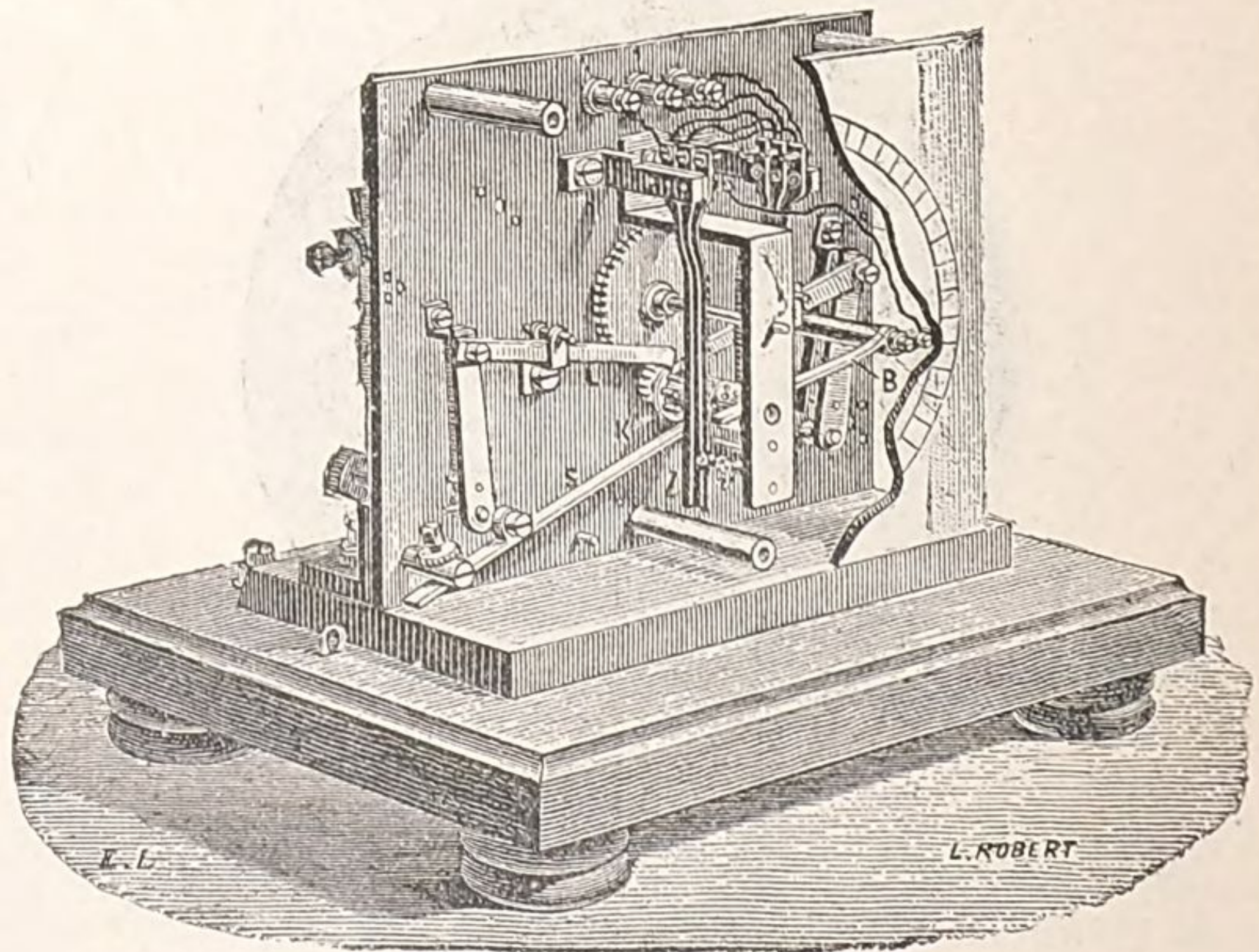


FIG. 9.

wires, *V*, *S*, *N*, to the receiver. If the temperature rises, the axis turns in one direction, while if it falls it turns in the opposite direction. The receiver shown in Fig. 9 has two electro-magnets behind the ver-

tical plate, operating by pawls, L, two insulated drums upon the same axis, which by means of pins on them acting on springs, *l*, open and close the circuit from the transmitter leading to the electro-magnets. One of these operates to turn the axis of the register to indicate a rise in temperature, the other magnet gives a reverse motion indicating a fall in temperature. It is to be noted that the circuit is only closed during a fraction of a second when the platinum point touches the mercury. These periodic and successive operations transmit to the receiver the fluctuations of temperature of the medium in which the transmitter is placed; and the same arrangement can be applied to barometers, manometers, and indicators of water level. In this way the level of water in the reservoirs on the Eiffel Tower and elsewhere was transmitted and recorded in the Machinery Gallery. The cost of a transmitter and a registering receiver is \$100, which is about the price of the Richard system. A silver medal was awarded to Messrs. Parenthou in Class 62.

Another apparatus for indicating the temperature at a distance, the invention of A. Berthélemy and T. Morin, was exhibited with surveying and other instruments by Berthélemy, of 16 rue Dauphine, Paris, who received a silver medal. The apparatus is based upon the varying resistance which an electric current experiences in traversing a wire plunged in a thermometric tube when the mercurial

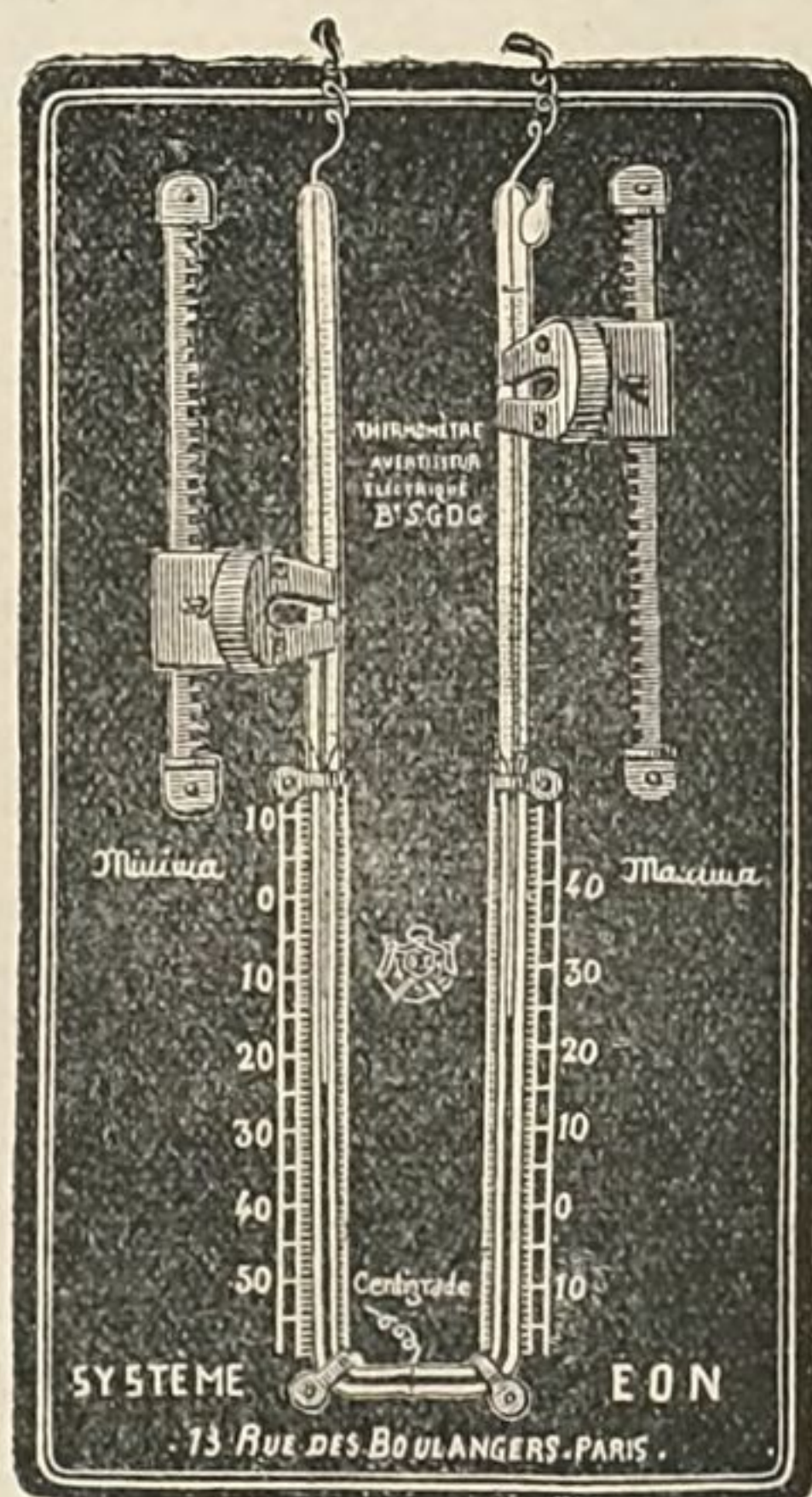


FIG. 10.

column rises and falls. This resistance is measured by the galvanometer of Marcel Deprez, whose scale is divided experimentally to degrees. There was an error of about 1° C. in transmitting the in-

dications of the thermometer at the Exposition, which was explained by the deterioration of the battery, and this suggests a difficulty in its practical use.

H. Éon, of 13 rue des Boulangers, Paris, exhibited a variety of meteorological instruments, the most novel of which was a thermometer giving warning when any desired temperature is reached. The maximum and minimum thermometer shown in Fig. 10, is U-shaped, like that of Six, but has above each tube a reservoir containing a platinum wire which descends to the thermometric column. On this wire slides a second wire having a spiral extremity with a glass index, containing a piece of soft iron, this serving as a contact for the magnets which slide at the side of each reservoir and are used to bring the spiral to the maximum temperature which is to be signaled. When the temperature reaches these points, the thermometer is put into communication, through a wire leading from the middle of the curved tube, with the battery and by the wires leading from the reservoirs with a bell, which accordingly rings. This thermometer is superior to those heretofore made, since the contacts work in a vacuum so that they are not easily oxidized. Its price is \$12, and it would seem to be applicable to a variety of purposes. For this and other exhibits a silver medal was awarded Mr. Éon.

Ph. Pellin, successor to Jules Duboscq, of 21 rue de l'Odéon, Paris, had a fine collection of physical apparatus, especially optical instruments, for which this house is noted. Among the newer meteorological instruments was the photo-polarimeter, constructed for Mr. Cornu in 1880. This apparatus resolves in a simple manner the problem of the measurement of the polarization of the light from the sky, in which it is claimed that a sudden variation forecasts a marked change in the meteorological conditions before the other atmospheric phenomena show any indications of a change. The light, introduced by an opening, is received on a Wollaston prism, by which the two images are polarized at right angles. A Foucault analyzer of Iceland spar is placed in the path of the rays, and by turning the analyzer equality is established between the two images. The instrument is arranged to measure the angle through which it was necessary to turn the analyzer to obtain this result, which gives the proportion of light polarized in either direction. The instrument is then turned 90 degrees on its axis, and a new observation made, and the sine of the difference of these two readings gives the per cent. of light polarized. The instrument is so delicate that it is possible to measure the polarization of the light from the sky during the night at the time of full moon. For this purpose the opening is enlarged and divided by a grating. This polarimeter is very portable, and does not require a stand. Its cost is \$24. The same firm showed the registering actinometer of Professor Crova, which dates from 1886. The essential part of this apparatus illustrated in

Fig. 11 is a thermo-electric pile, with a pair of thin disks of iron and German silver forming the couples. One of these disks is shielded from all solar radiation, the other receives normally on its blackened surface the solar radiation transmitted through a series of thin aluminum diaphragms pierced with openings of decreasing size up to the smallest, which is 4 millimetres in diameter, and faces the actinometric disk. The whole is enclosed in a brass tube, B, equatorially mounted and placed on a roof, the register, A, nearly identical with

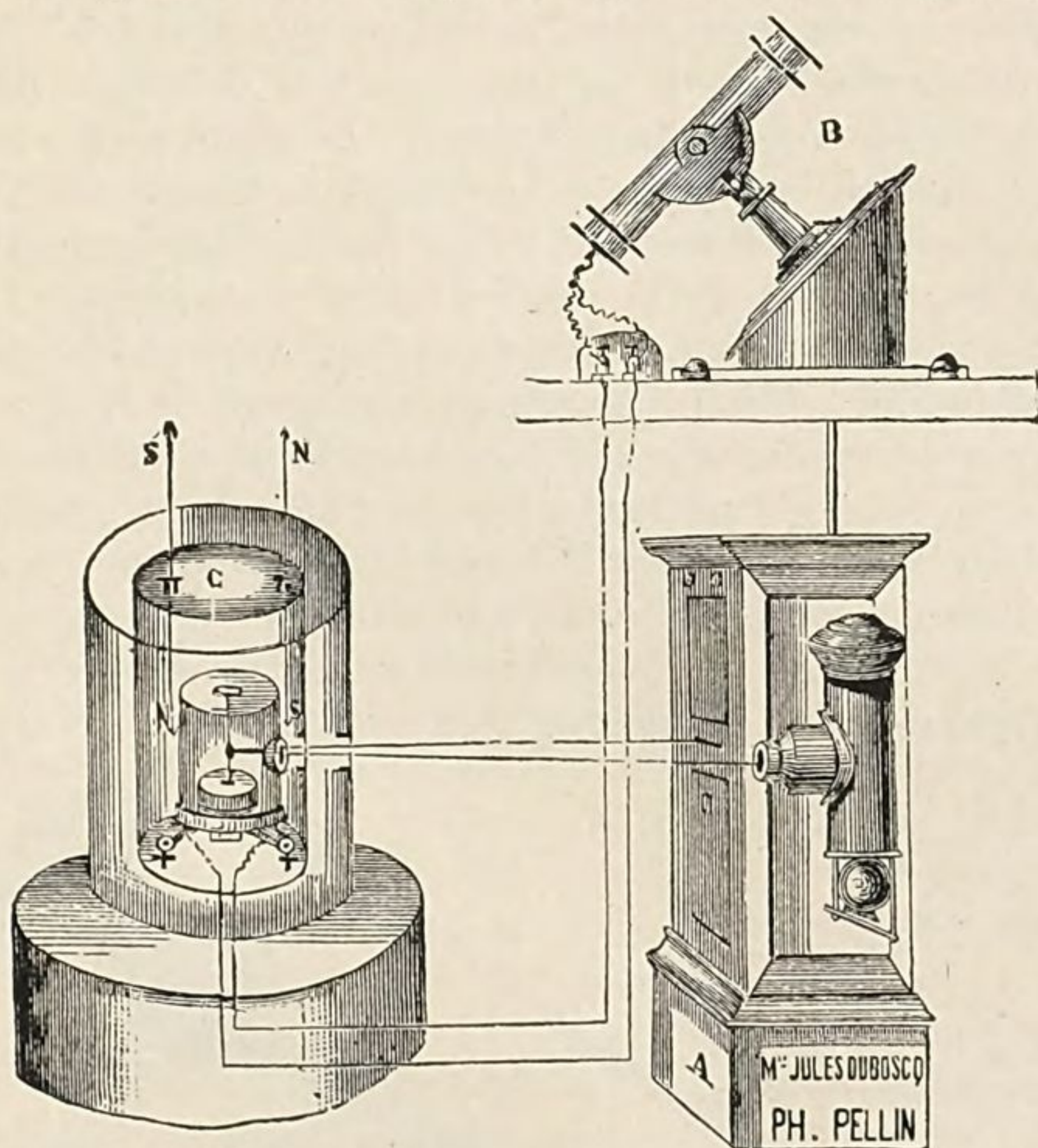


FIG. 11.

those which Mr. Mascart employs for magnetic and electric registration, being in a dark room under the instrument. A clock operates the photographic frame, and at the same time, by means of a shaft, turns the actinometric tube, which is thus constantly centered in the direction of the sun. Flexible and insulated conductors connect the tube with an astatic mirror-galvanometer, C, which is protected from diurnal variations of magnetic intensity and declination by a double envelope of sheet iron with openings for the passage of the luminous rays, and an iron cover with two symmetrical holes for the magnetic needles, which can be raised in order to form a magnetic field of a variable intensity which directs the astatic system. The conversion of the ordinates of the curve into calories is made from absolute determinations of the calorific intensity of the solar radiation; at the instant of the determination the light of a distant lamp is sent through the register-slit, which traces a black line, whose

position gives the time of observation and whose ordinate represents the absolute intensity at that moment. The price of this apparatus complete is \$340. A gold medal was awarded Mr. Pellin for his exhibit.

E. Ducretet & Co., 75 rue Claude Bernard, Paris, another firm celebrated for the construction of physical apparatus, had a very fine exhibit, including the actinometer for direct observations of Professor Crova illustrated in Fig. 12. This instrument, which dates back some ten years, is, nevertheless, not yet sufficiently known to meteorologists. It is based on the dynamic method of observation, which consists in observing the change of a thermometer exposed alternately for the same length of time to the solar rays and in the shade. This method offers for meteorological stations and for observations made in the field these advantages: it is not necessary to wait until the instrument has acquired a stationary temperature (which is often very long), but it suffices if it has about the air temperature, and it is not necessary to measure the temperature of the envelope containing the thermometric reservoir. A complete observation thus requires less than a quarter of an hour. The actinometer is composed of an absolute alcohol thermometer, R, T, r , whose reservoir, R, is covered with a thin layer of silver deposited on the glass, which is again coated with platinum black, whose

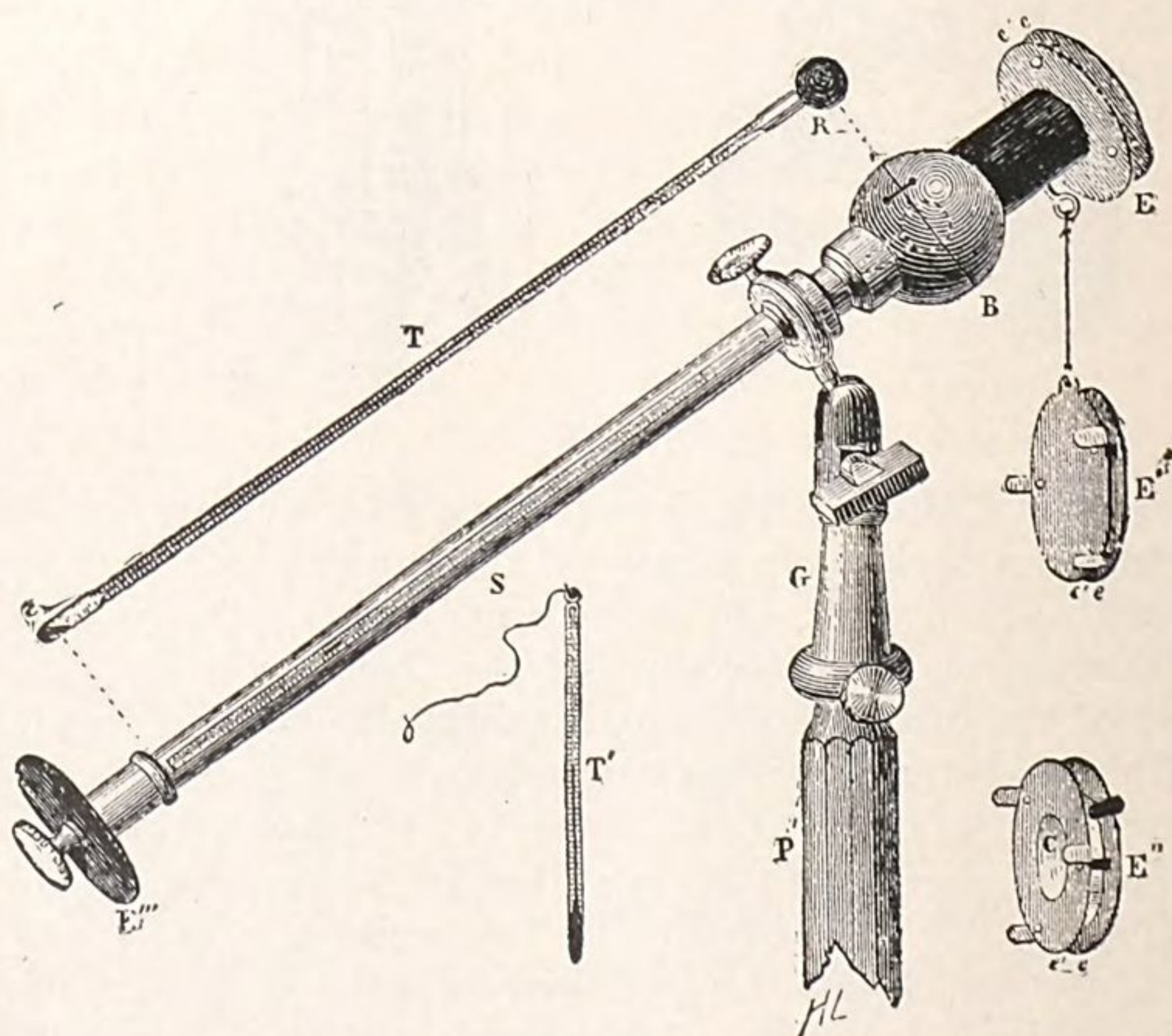


FIG. 12.

absorbing power is equal to that of lampblack. A few drops of mercury in the reservoir permit an index to be formed in the tube, by which the augmentation of volume of alcohol in the reservoir

under the influence of solar heat can be measured; a bulb, *r*, at the end of the thermometric tube receives the excess alcohol and the indices of mercury. The tube is divided into equal parts, and the corrected movement of the index is converted into calories received normally on a surface of 1 square centimetre, with an absorbing power equal to unity, by means of a variable coefficient for each instrument. The reservoir is fixed in the center of a spherical envelope, *B*, blackened inside and nicked outside, and the solar rays penetrate by a circular orifice pierced in a double polished metal shield, *E*. Another double shield, *E'*, excludes the solar rays when necessary, and a disk, *E''*, at the other end of the instrument permits it to be placed in the direction of the sun by means of a ball and socket joint. The instrument is supported on a light tripod, *P*, which folds together and packs in a convenient case for transportation. This case also contains a disk with parallel faces, *E''*, filled with distilled water, to be mounted on the orifice of the actinometer, intended to measure the absorption of the solar rays exerted by a layer of water 1 centimetre thick, and two sling thermometers, *T'*, with wet and dry bulbs, intended to measure the temperature and relative humidity of the air. The price of the actinometer is \$30. For their general exhibit Messrs. Ducretet received a grand prize.

Alph. Huetz, mechanician to the International Bureau of Weights and Measures at Sèvres, exhibited an apparatus to determine the position of the 100-degree point of standard thermometers, derived from Regnault's apparatus, but modified by Mr. Chappuis of the above bureau. It is composed of a solid base supporting a boiler, a tube with a double circulation of steam, a condenser, and a water manometer. It differs from the early apparatus chiefly in having the tube in which the thermometer is placed separated from the boiler, which prevents the direct action of water on the thermometer; and furthermore this tube, which is carried on a pipe forming the axis, can be placed in a vertical or a horizontal position. The condenser avoids the necessity of frequently filling the apparatus. There are improved devices for suspending the thermometer, and a telescope is attached to the tube in which it is placed. The movement of the tube is very useful for the direct determination of the coefficient of interior pressure of the thermometers, and the coefficient being also calculated by adding to the coefficient of exterior pressure a correction for the compressibility of mercury and glass, there is by direct determination a control of the operation. This apparatus has been in use for more than four years at the International Bureau of Weights and Measures, and has served for various thermometric researches as well as for the tests of all the thermometers of the bureau and of those which will be distributed this year to the states of the Metric Convention. A silver medal was awarded to Mr. Huetz for the apparatus.

L. C. Baudin, of 276 rue St. Jacques, Paris, showed some very fine standard thermometers. The progress which he has made in this work since 1878 is as follows: June, 1883, invention of the mercurial thermometer reading to 460° C.; 1885, construction of the alcohol thermometer, giving indications comparable to the air thermometer between 0° and 100° C. by applying the corrections determined by Mr. A. C. White, of the Massachusetts Institute of Technology; December, 1887, construction of annealed thermometers by the method of Crafts and Friedel. Baudin, who claims to have been the first maker to adopt this method of obtaining an invariable zero, has since modified the method, and offers to furnish thermometers which will always return to the same zero within the thousandth of a degree, whatever may be the number or length of the boilings. Under these conditions, the hypsometric thermometer compares favorably with the mercurial barometer for the measurement of heights, and the hypsometer shown, which measures only up to 500 metres, permits differences of level of half a metre to be read. The price of a standard thermometer, divided in 0.1° C. from -1° to $+101^{\circ}$, and warranted exact to within 0.08° C. for the whole scale, is only \$11. The annealing process, giving an invariable zero, is also applied to the ordinary meteorological thermometers.

J. Tonnelot, of 25 rue du Sommerard, Paris, besides a fine display of the standard meteorological instruments, such as are supplied to the Central Meteorological Bureau of France, exhibited six thermometers made for the International Bureau of Weights and Measures. The tubes were of hard glass, 50 to 70 centimetres long, with equidistant divisions by tenths of degrees, the length of a degree varying from 5.5 to 10 millimetres. The thermometers covered a range of temperature from -30° to $+102^{\circ}$ C., most of them having one or more intermediate chambers in order to reach such extreme temperatures. The prices of these thermometers varied from \$6 to \$10.

Both Messrs. Baudin and Tonnelot received gold medals in recognition of the fact that they were the best makers of thermometers, while the work of Tonnelot included also other meteorological instruments.

A very sensitive barograph was that of G. Raymond, which is constructed as follows: A light float in the short leg of a siphon tube acts by a silk thread upon an arc fixed on the shorter arm of a lever made of cane, whose other end traces its motion by a fine needle upon a drum covered with lampblack paper. The drum is turned on a vertical axis by clockwork in seven days, and the trace is permanently fixed upon the detached paper by covering it with gum solution. The correction for the expansion of the mercury by heat is obtained by making the cross sections of the two legs of the tube equal and properly proportioning the height of mercury in the short

leg. This barograph, which costs \$56, has been in use at the Park of St. Maur Observatory since about 1885. A silver medal was awarded Mr. Raymond for it.

Naudet & Co., Pertuis & Son, successors, of 4 Place Thorigny, Paris, had a fine exhibit of aneroid barometers, for whose manufacture they are noted, and their trade mark $\begin{pmatrix} H \\ P \quad B \\ N \end{pmatrix}$ may be found on many instruments sold by other dealers. It was this firm which in 1860 perfected the holosteric barometer invented by Vidi in 1847, by substituting for the spiral spring employed by him to resist the atmospheric pressure an arched steel spring, and also compensating the effect of temperature by making of two metals the lever which transmits the movement of the counterspring to the dial needle. A gold medal was awarded to Messrs. Naudet & Co. for their barometers. No radical improvements have lately been made in the construction of aneroid barometers, but their size and price have been

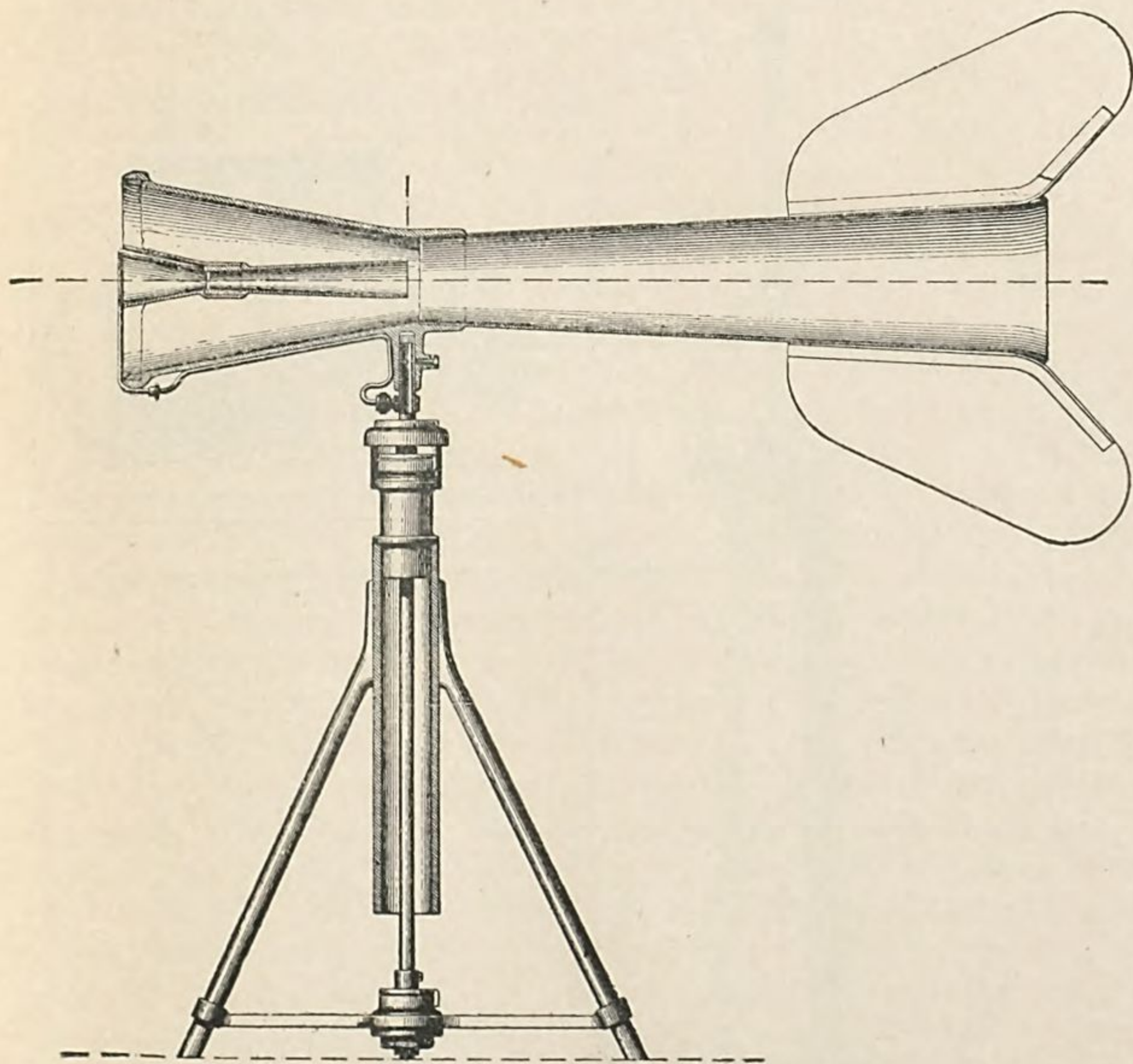


FIG. 13.

much reduced. Thus Renault, of 122 avenue Parmentier, Paris, sells an aneroid with a copper case and a card dial for the wonder-

fully low price of 70 cents, and has pocket instruments for mountain use at \$2.50. To this maker, to T. Huë, 79 rue des Gravilliers, Paris,

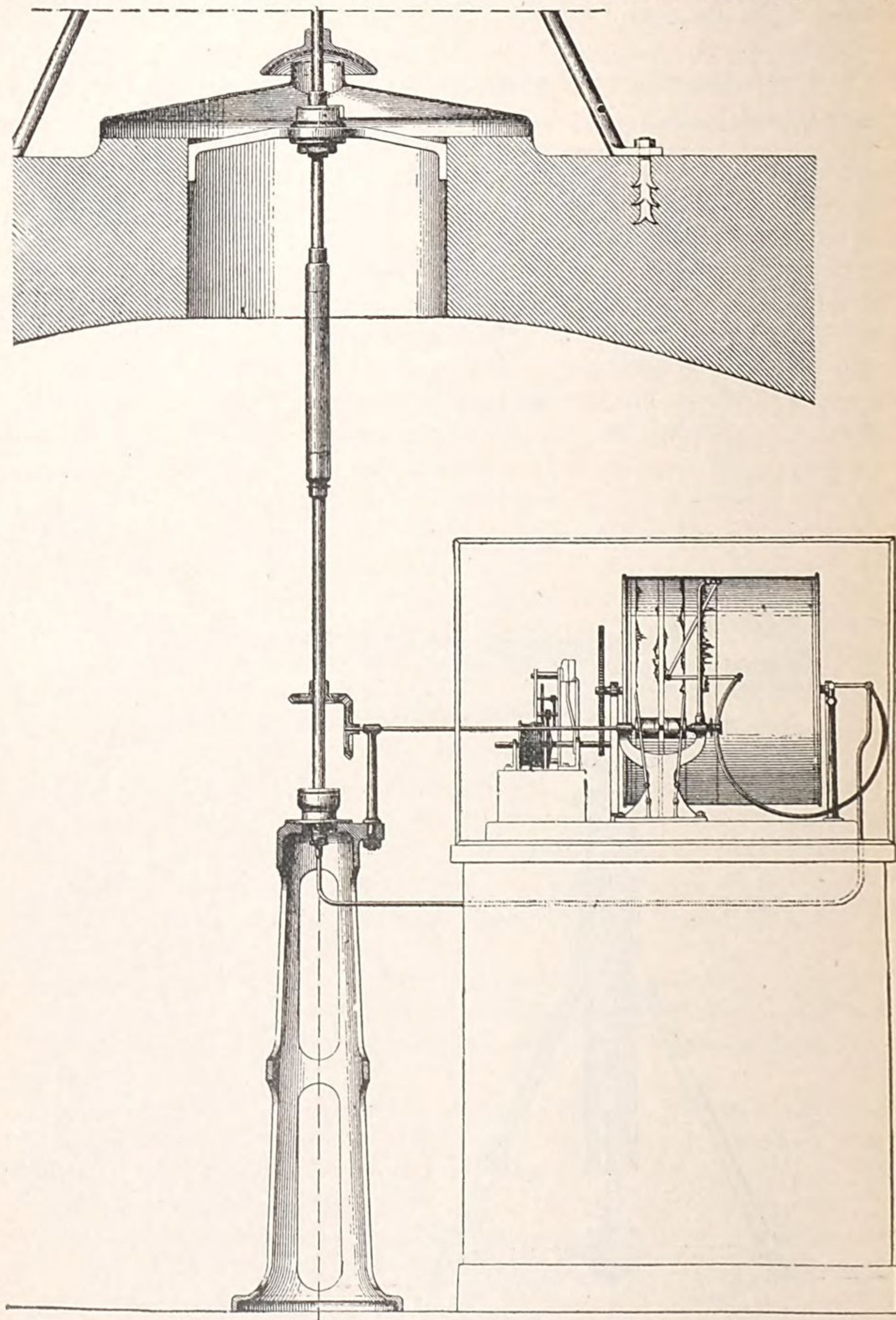


FIG. 14.

and to F. Perillat & Son, 52 rue du Faubourg-du-Temple, Paris, silver medals were awarded for aneroid barometers.

The anemograph invented by Eug. Bourdon in 1882 has been perfected by his son, Ch. Bourdon, engineer, 26 Boulevard Magenta, Paris. This apparatus, which registers the velocity and direction of the wind, depends on the effect which the convergent-divergent tubes of Venturi have of producing at the point of reunion of the truncated cones a vacuum which is about five times greater than that produced by the entering current of air. Mr. Bourdon placed, one behind the other, several concentric tubes of this form, but of decreasing diameters and small enough to occupy only the central part of the contracted section of the outer tube. Ordinarily the anemometer has two tubes, as shown in Fig. 13; but if the instrument is designed to measure small velocities, a third tube may become necessary. The action is as follows: When there is a single tube there is produced at the point of intersection of the two cones a suction caused by the contraction of the fluid vein at this place. If a second tube be fixed so that its divergent extremity is exactly at the point of intersection where the fluid vein attains its maximum contraction, the air will flow into this tube, not only by virtue of the propulsion which the current has as a whole, but still more by the influence of the atmosphere, which exerts all its weight on the entering orifice, while the exit is immersed in a medium where the air is considerably rarefied. The relations of the vacua at the entering orifice of the biconical tube and at the point of intersection, as determined by a manometer, are as 1 to 6. If a second and third tube of the same shape but decreasing dimensions be placed one behind the other, the effect will be to increase the vacuum, and consequently the velocity of flow of air produced in the last tube, the increase being 1 to 20 with two tubes and 1 to 80 with three. In the register of this anemometer (shown in Fig. 14) the Venturi tube is connected by a pipe with a curved tube of elliptical section—such as is used in the Bourdon barometer—fixed at one end, whose free end is connected by levers with the registering-pen, by which the variations of pressure are continuously traced upon a cylinder turned on a horizontal axis by clockwork once in eight days. By the movement of the Venturi tube, which is pivoted so as to face the wind, its direction is registered upon another portion of the cylinder by means of pens actuated by cams. This apparatus has the advantage of simplicity, and by magnifying considerably the scale of velocities, it is claimed accurate results may be obtained. Since there is only the friction of the air upon the sides of the tube, the transmission of the movement is not sensibly diminished, and each gust of wind is instantaneously registered just as it occurs. The resistance and friction remain nearly constant, and the conical form of the tube counteracts small inclinations in the wind's direction, though the tube does not easily put itself in the direction of the wind when its velocity is small. There is, however, a considerable difficulty in determining experimentally

the velocity of the air entering the tube in order to form a scale for the register. Such anemographs are in use at the observatories of Paris and Perpignan, and at several foreign observatories.

Golaz & Son, of 282 rue St. Jacques, Paris, showed several forms of dew-point apparatus. That of Regnault is well known to physicists, but is little employed in meteorological observations. The Alluard condensation hygrometer, illustrated in Fig. 15, is a modification of it, and consists of a hollow square prism of polished brass, A, having one of its faces surrounded by a polished brass frame, B, which, however, does not touch the prism. Since this frame is never cooled below the air temperature, it remains bright, and the deposition of

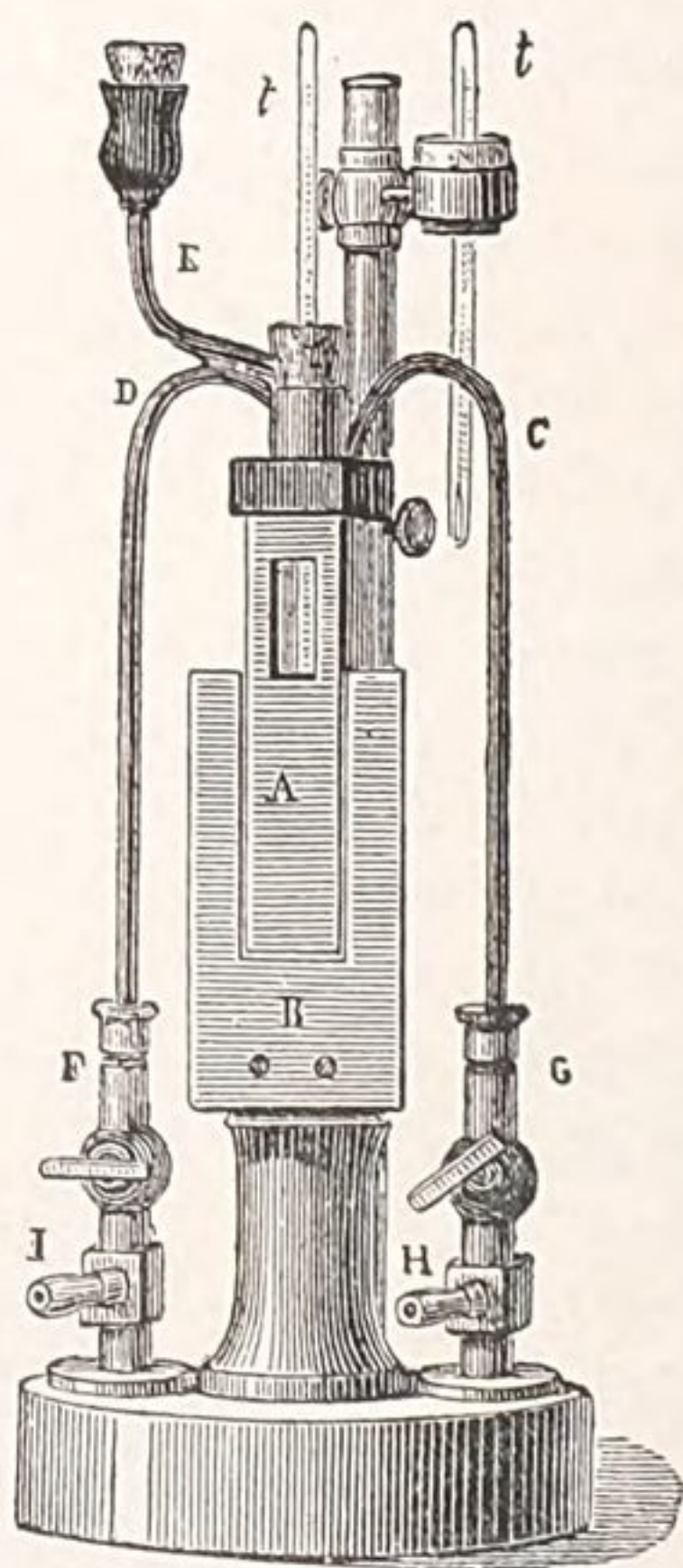


FIG. 15.

dew is easily observed by the contrast of the face of the prism, cooled by the evaporation of ether within. A thermometer, t , dips into the ether contained in the prism, which is agitated either by blowing or aspirating air through the tubes, C or D, which are connected at H and I, below the cocks, G and F, with rubber tubing having inspirating or aspirating bulbs. The tube at E serves to introduce the ether. The temperature of the adjacent air is determined by means of a sling thermometer, t' . The apparatus packs compactly in a box for transportation, and its price is \$24. The hygrometer, with internal condensation of Professor Crova, was designed to meet the case when the air being in motion and the dew point much below the air temperature, the air moves over the surface of the metal without completely establishing equilibrium of temperature, so that the hu-

midities obtained are too low. The apparatus shown in Fig. 16 consists of a thin brass tube, nicked and polished inside. One end is closed by ground glass, and at the other is a lens permitting the interior of the tube to be seen, while a black screen eliminates the effect of the exterior light. The tube is fixed in the axis of a prismatic box filled with sulphuret of carbon and furnished with two stop-cocks, by one of which a current of air is blown in by the mouth, cooling the solution and tube by evaporation, while from the other the air charged with vapor is discharged. A thermometer passes through the box and is in contact with the tube. The external air, by the

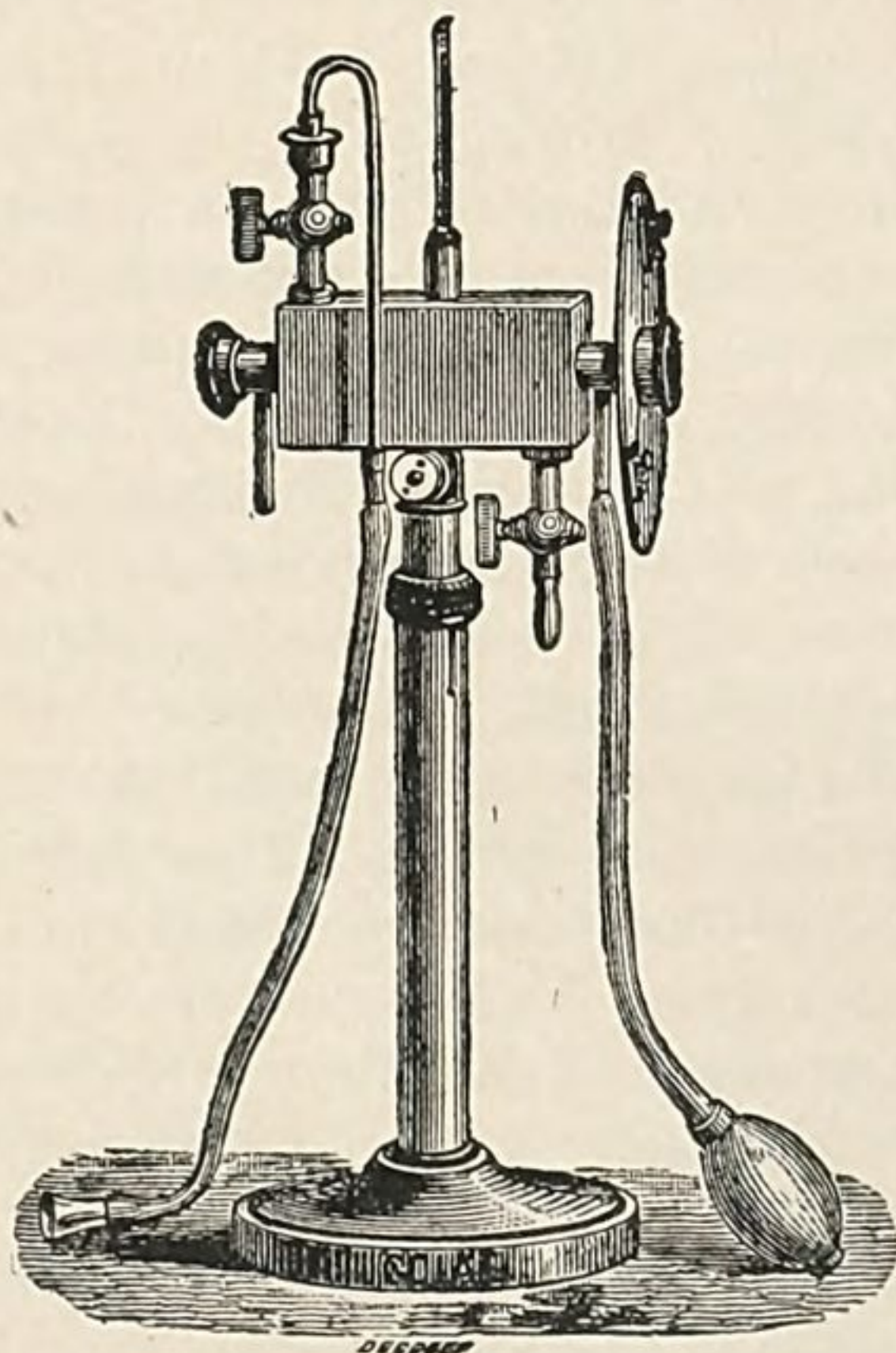


FIG. 16.

action of an aspirating bulb, is drawn through the tube, which is cooled as before described until its brilliant interior is seen to become spotted with moisture. These spots are allowed to disappear, and at that instant the temperature of the dew point is read from the thermometer to within 0.1°C . The dew points thus obtained are always higher than those given by hygrometers with external condensation. In calm, warm, and damp weather the differences are small; but they increase with the motion and dryness of the air. The Crova apparatus complete costs \$26. For these and other instruments exhibited Messrs. Golaz received a gold medal.

The Physical Laboratory of the Sorbonne showed in Class 8 the registering hygrometer of Nodon, which was presented to the Academy of Sciences in 1886. The hygrometric material is a series of compound spirals of gelatine and cardboard wound on two horizontal axes. These give a pencil motion at right angles to paper unrolled

by clockwork, so that the ordinates of the curve traced represent degrees of relative humidity, while the abscissæ represent the corresponding times. It may be remarked that among registering meteorological instruments hygrometers are perhaps the most unreliable, for ordinarily they act by absorption, and the distortions which the hygrometric substances undergo are generally variable with the temperature, while the substance itself deteriorates with age. Gelatine, however, which is employed in the above-described hygrograph, does not appear to possess these defects.

Chateau & Son, of 118 rue Montmartre, Paris, the successors of Collin-Wagner, exhibited a registering rain gauge permitting two phenomena to be recorded at the same time. The rain passes from the gauge into a cylinder, in which is a float connected to a wire passing over a pulley, and thus moves in vertical guides a pencil attached to an electro-magnet, which registers the upward motion of the float on a drum turning in twenty-four hours about a vertical axis. A second auxiliary drum is placed at the right of the one in use, and permits a change to be made without stopping the apparatus, and it is also furnished with an arrangement for dividing the paper covering the cylinders. The electro-magnet controlling the pencil serves to register any indeterminate phenomenon, when a current is passed, without affecting the rain registration. The same firm showed a mareograph, or fluviograph, with nearly the same arrangement of parts. Messrs. Chateau were awarded a gold medal.

Several Paris constructors had good collections of the standard meteorological instruments. In addition to those already mentioned there were Alvergnyat Brothers, of 10 rue de la Sorbonne, A. Baserga, 29 Quai de l'Horloge, and J. Boulan, 5 rue Royer Collard. The instruments of the last-named firm were especially noticeable for their fine finish. Messrs. Alvergnyat, who exhibited in Class 8, received a gold medal, and the other two firms obtained silver medals in Class 15. The cost of standard meteorological instruments in France is so much less than that of the same grade of articles in England and the United States that the average prices of some of the French makers are quoted. A small Fortin barometer for meteorological stations, and a Renou barometer with a large cistern and compensated scale, each cost about \$20. A psychrometer can be had for about \$4; maximum and minimum thermometers for \$1.60 and \$1.20 respectively. The price of rain gauges varies from \$2.40 to \$18.

In the retrospective exhibition were some historically interesting meteorological instruments. Among the instruments used by Lavoisier (1743-1794) were various thermometers filled with alcohol or mercury, having their bulbs formed of a spiral tube with the axis in a vertical or horizontal plane, a thermometer with a vernier, and one of Fortin, dated 1786, with a sliding scale. A Saussure hygrom-

eter constructed by Richer in 1788, was likewise shown in the collection. Another historical instrument was the anemometer of d'Ons-en-Bray, belonging to the Conservatoire des Arts et Métiers, which was constructed about 1734. This is the first rotation anemometer of which we have a description, and was the first to have clockwork applied for registration. By means of a rude system of gearing connecting a vane and windmill, the wind direction and velocity were recorded during twenty-four hours.

A comparison of these crude instruments with those representing modern meteorological science illustrates strikingly the progress which has been made since the last century.

II.—THE FOREIGN SECTIONS.

As has been before remarked, the small exhibit of the foreign countries suffered by being scattered over a large area, rendering the instruments difficult to find and to compare with one another.

The exhibit of the United States Signal Service was meager, and gave an inadequate idea of the magnitude of the work done, and the superiority of the American over the foreign weather services, in the speedy and graphic manner in which meteorological data covering an immense territory are placed before the public. Some charts and other publications of the national and coöperating state weather services were on view, but the only instruments shown were a mountain barometer and the new triple register for wind velocity and direction and rainfall.

The barometer was of the Fortin type with a double vernier, and had the new Tuck cistern in which the usual leather bag holding the mercury is replaced by a cylinder with a packed metallic piston. The Gibbon self-register for electrically recording the wind has long been in use, but for obtaining a record of the rainfall on the same sheet Professor Marvin has devised an arrangement by which a float in the tube connected with the receiver of the gauge makes an electric contact, by means similar to those in the anemometer, for each five-hundredths of an inch of rainfall.

General Greely, Chief Signal Officer, U. S. Army, explained the unsatisfactory representation of the work and methods of the Signal Service on the ground that the Signal Office had no money and received no direct encouragement from any one, and only made the exhibit at the last moment, when urged to do so by a representative of the French Government. The exhibit, therefore, consisted only of such articles as could be gathered together without expense, and at that time, also, by misfortune, the office was being moved, and its instruments and records were scattered. The jury appreciating the fact, and being cognizant of the merits of the Service, awarded three grand prizes in Classes 8, 15, and 16.

Next to Richard Brothers, the most extensive collection of regis-

tering meteorological instruments at the Exposition was that of Th. Usteri-Reinacher, the successor of Hottinger and Goldschmid, of Zürich, Switzerland, who received a gold medal. It seems probable that Mr. Goldschmid in 1873 made the first registering aneroid barometer, which was exhibited at the Vienna Exposition of that year, where it obtained the medal of progress. In this instrument the clock movement was placed in the drum around which the paper register was rolled, the drum turning once in twelve hours during ten days. Another drum, also with its axis vertical, contained the pile of vacuum boxes without a balance-spring, and had a screw arrangement for setting the instrument to the proper reading. This barograph registered the indications periodically, a hammer, controlled by clockwork, driving the point of the marking lever against the paper. Mr. Hottinger modified the construction by placing the drums horizontal, altering the number of vacuum boxes, and applying to them a balance-spring. Although this form of the instrument is still made, Mr. Usteri-Reinacher has within a few years adopted the Richard type with continuous registration, with the principal difference of using an exterior balance-spring instead of interior ones to counteract the pressure upon the vacuum boxes, and of placing the clock underneath the register drum, so as to facilitate the change from weekly to daily revolutions by a shift of gear wheels. Minor differences consist in providing the levers with knife

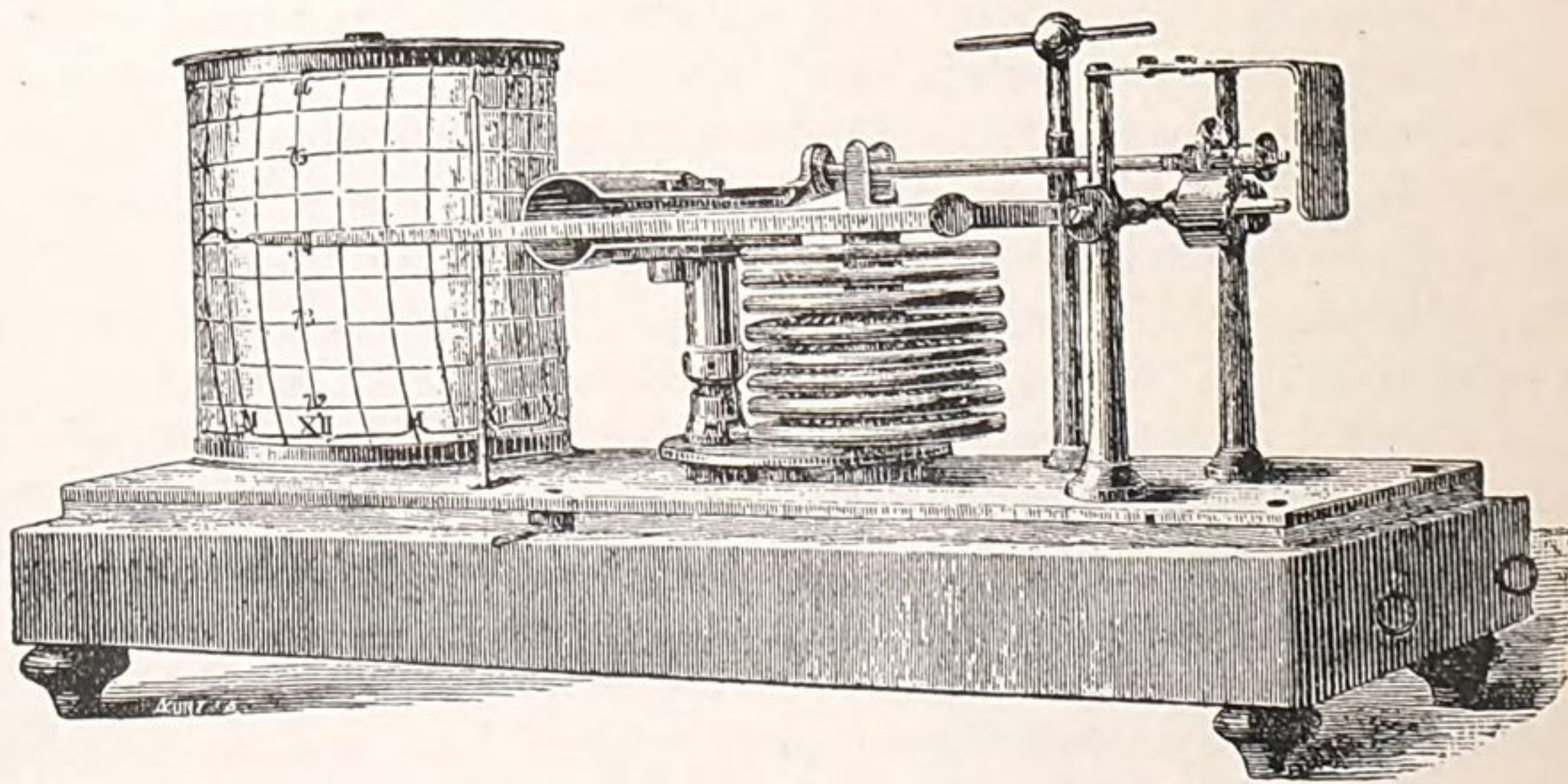


FIG. 17.

edges capable of adjustment, placing the unequal lever arms in one straight line, and providing means for adjusting the reading without disturbing the instrument, by turning a handle which raises or lowers the plate carrying the vacuum boxes. This barograph is illustrated in Fig. 17.

This same mode of registration is employed in the thermograph made by Usteri-Reinacher, where the thermic motor is not the curved tube containing alcohol employed by Richard, but a bimetallic bar

bent in a circle, and, presumably, less sensitive to temperature changes than the former. The price of the Swiss instruments is considerably higher than the French, the barograph costing \$37 and the thermograph \$35, as compared with \$25 for both the Richard barograph and thermograph. The Hottinger pluviograph shown in

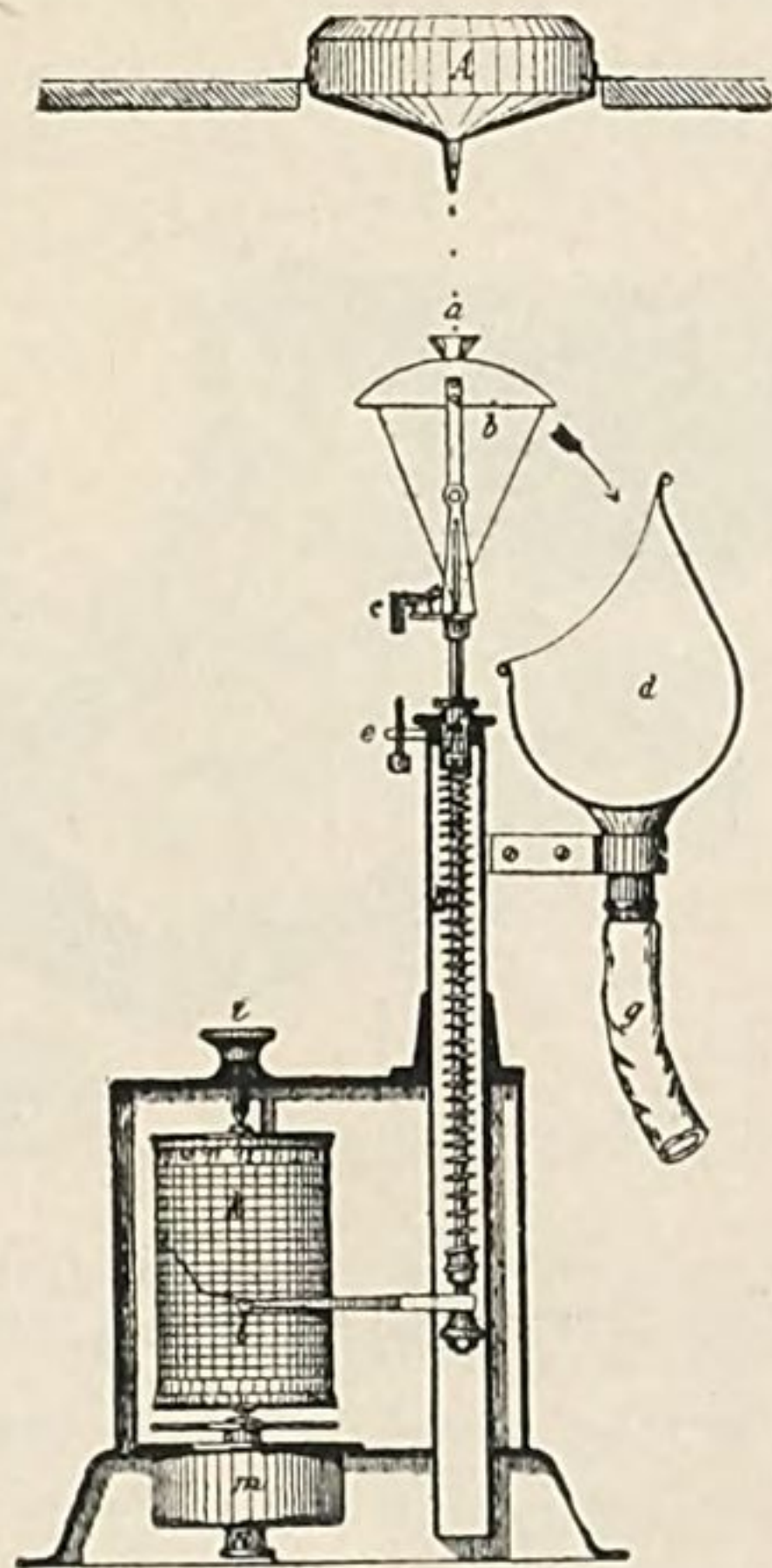


FIG. 18.

Fig. 18 has a tilting bucket, *b*, resting on a spiral spring, *H*. After a certain quantity of water has entered from the receiver, *A*, through the funnel, *a*, the increased weight of the bucket causes it to compress the spring and to descend until the lever, *c*, strikes the screw, *e*, when it empties itself into the receptacle, *d*, and returns to its original position. The motion of a pencil, *l*, attached to the spring is recorded upon a vertical cylinder, *k*, covered with paper, and turned on its axis once a day by clockwork at *m*. This pluviograph would seem efficient when no snow is to be recorded, and its cost (\$40) is less than that of other recording gauges. The English photographic sunshine recorder, or heliograph, of Jordan, has been modified by Dr. Mauer, of Zürich, so that instead of the two curved traces representing the morning and afternoon sun, respectively, there is but a single straight trace for the whole day which is normal to the divisions representing the hours. The instrument shown in Fig. 19 consists of a cylinder, larger than the English one, with its axis parallel to that of the earth, and cut by a horizontal plane, in which a hole permits the sun's rays to reach the blue print paper contained in the cylinder. This paper is inserted by removing a cover at the

lower end of the cylinder, but this is inconvenient, and can hardly be done without displacing the instrument from the meridian, and it would seem better to have the cylinder removable from the socket, so that it could be taken indoors to change the paper. The price of this heliograph (about \$13) is less than one-third that of the burning heliograph of Campbell.

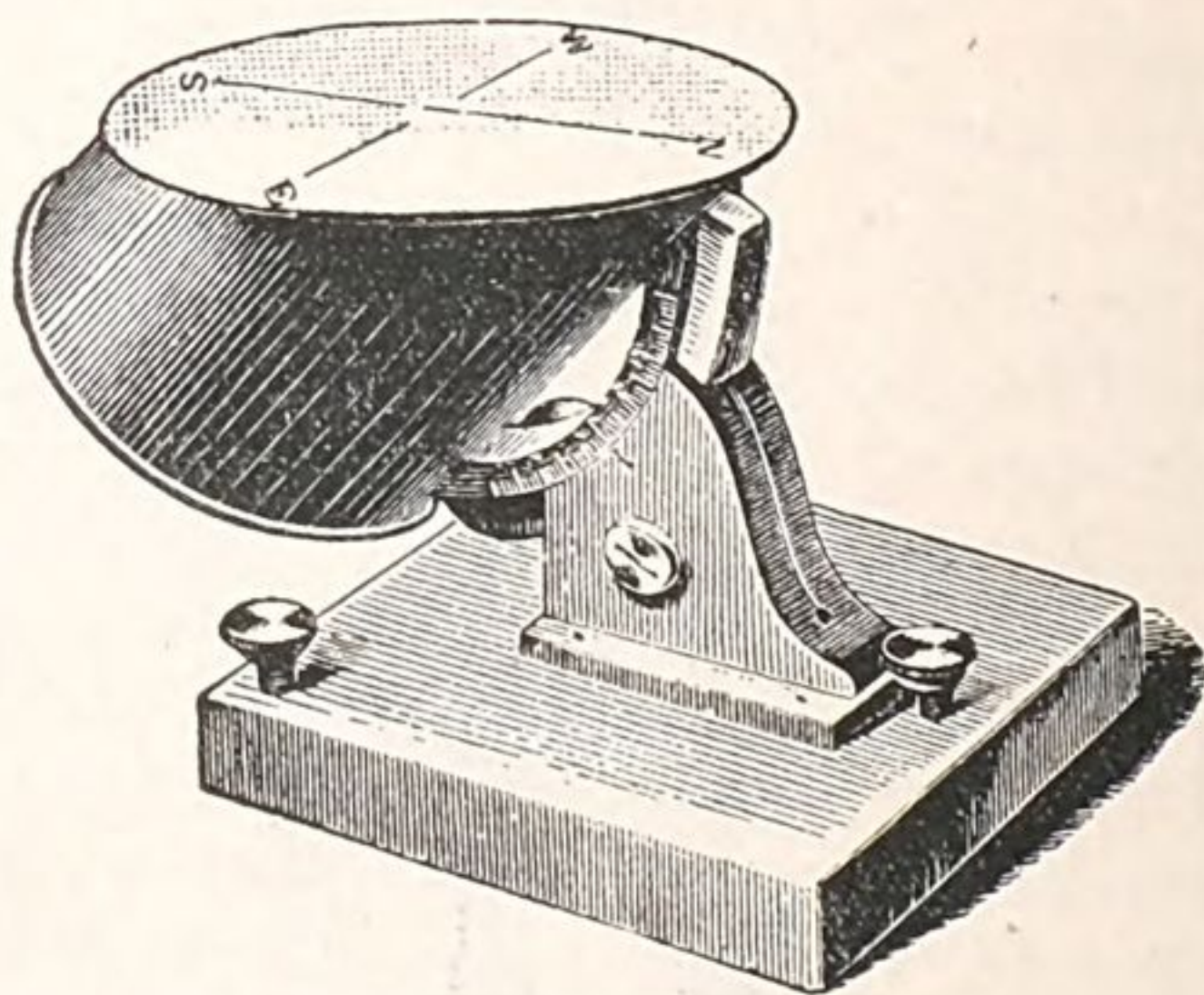


FIG. 19.

Two instruments for direct observation made by Usteri-Reinacher merit notice. The hair hygrometer of Dr. Koppe, shown in Fig. 20, is probably the best of its kind, and costs only \$9. A simple method of testing its readings at saturation is furnished by means of a frame covered with muslin which forms the back of the case.

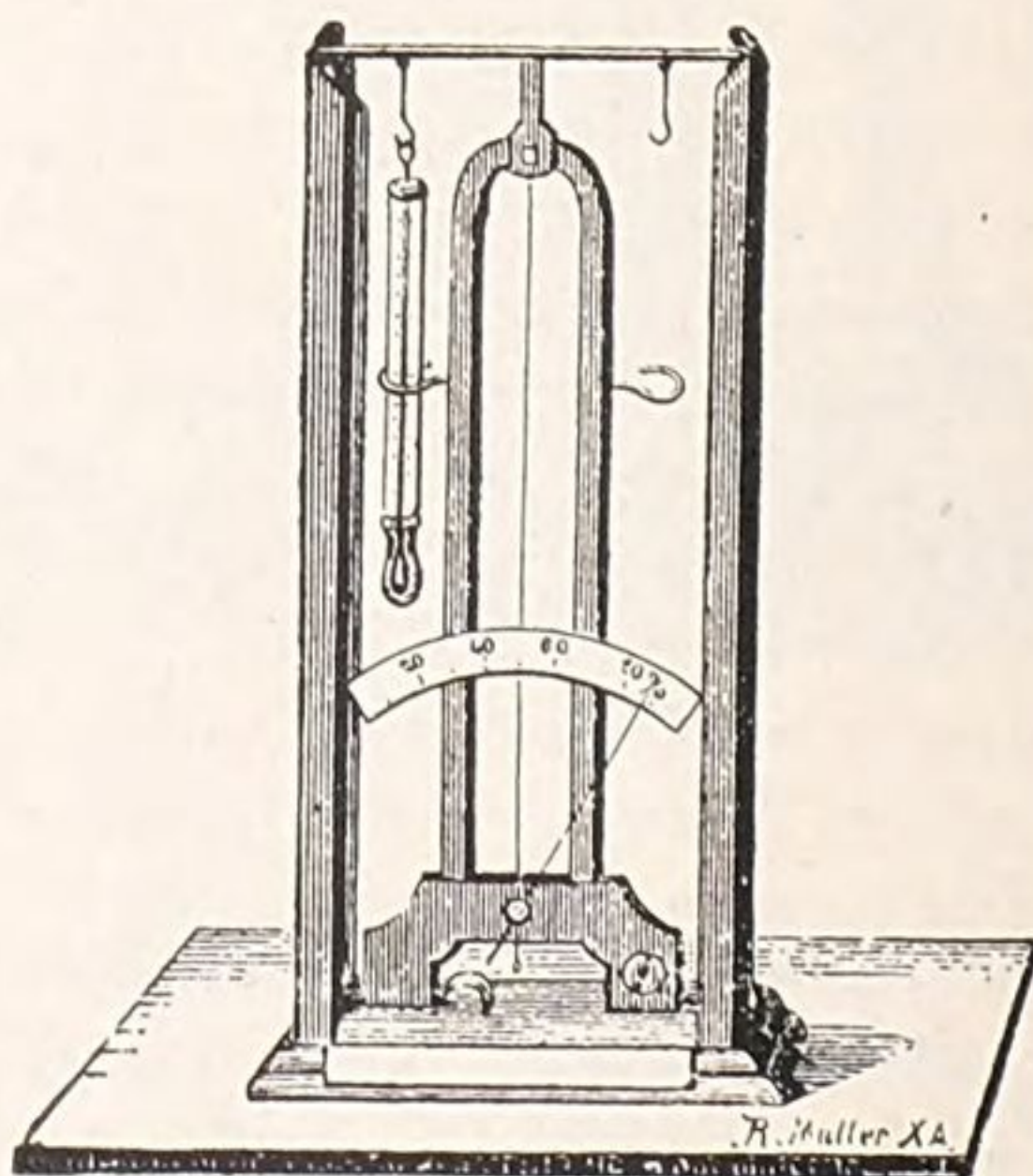


FIG. 20.

When this is wet the contained air is saturated, and the index is adjusted to indicate 100. In the Goldschmid aneroid barometers, which date from the year 1857 and are much used by engineers and

surveyors, the setting and reading are rendered very fine by means of a microscope and a micrometer screw. In Fig. 21, on the left, an exterior view of the barometer shows the head of the micrometer screw, *T*, and the microscope, *P*, pivoted at *H* to the case, *G*. A vertical section of the instrument reveals the connection of the vacuum box, *a*, with the index-lever, *e*, turning about the fulcrum *e''*. The micrometer screw *M* rests upon the movable lever, *e'*, also pivoted at *e''*, which for reading is brought in line with the lever, *e*, as seen in the magnified view of the scale on the right, in which each division of the vertical scale, *f f*, represents one turn of the micrometer screw, or

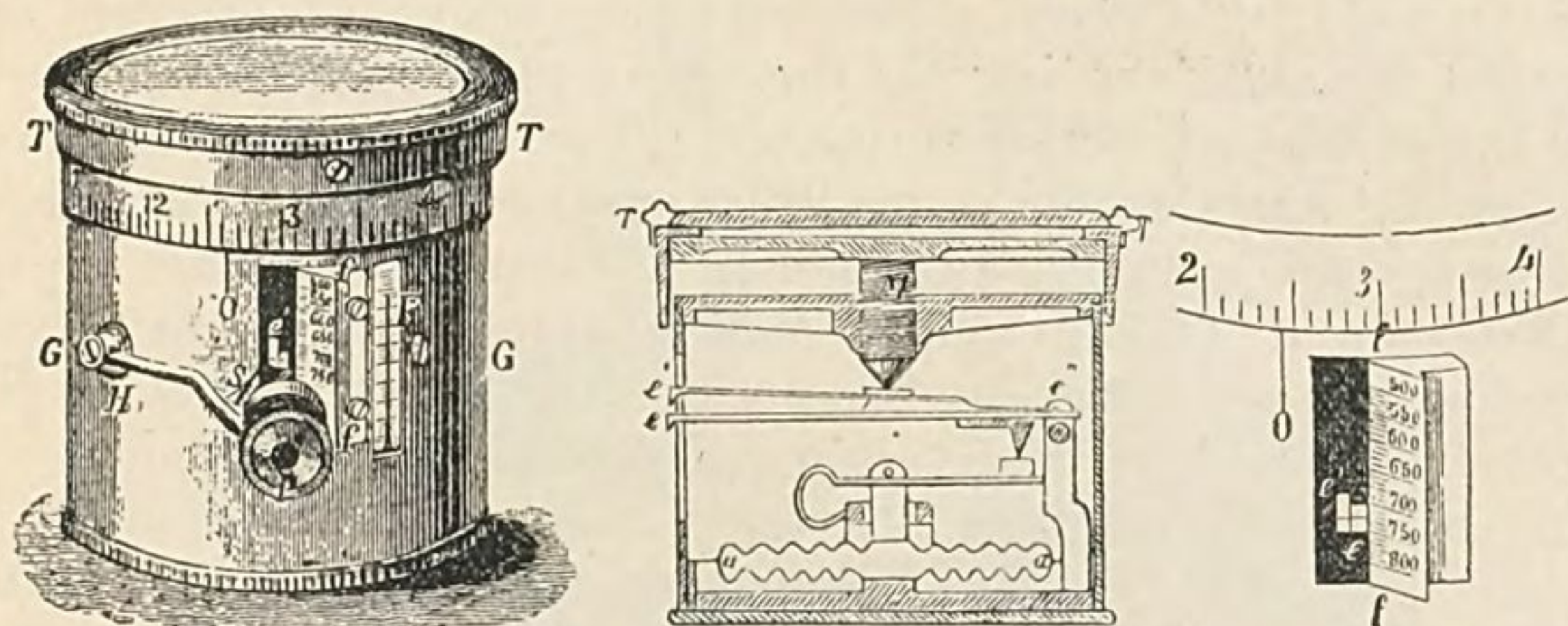


FIG. 21.

10 millimetres. Partial compensation for temperature is obtained by leaving some air in the vacuum box, but a table of temperature corrections is furnished with each barometer; we know, however, of one instrument in which the errors instead of the corrections were given, thus doubling the error of the corrected observation. The price of the pocket barometer is \$20, and that for surveyors' use, \$30.

The Dutch house of H. Olland, of Utrecht, which is well known for its construction of balances of precision and of meteorological instruments, particularly of the tele-meteorograph, which transmits by a single wire to a central station the indications of various instruments, showed two registering meteorological apparatus. One of these, the anemometrograph, gives a graphic representation of the direction, force, and velocity of the wind. The direction is noted by one of three pens fixed on an endless ribbon and moved by the vane. If the wind rotates more than 360 degrees the pen which first marked the direction is replaced by a second. The anemometer is constructed on Osler's and Robinson's systems. The spring which measures the force of the wind is placed behind the plate and below the vane. This spring, shaped like a carriage spring, is of tempered steel, and is so adjusted that for light pressures the pen moves farther than for heavier pressures, by which means the former are noted more exactly. The transition from light to heavier pressures is indicated in a regular manner so that, for example, it decreases for each 5 kilogrammes increase of pressure. The registration of wind

velocity is made with an open circuit, so that in a calm the contact remaining closed by the Robinson cups does not exhaust the battery, and high and low velocities are equally legible although the paper moves but 8 millimetres per hour. In the wind-wheel the contact occurs after each one hundred and fifty revolutions which correspond to about 500 metres traveled by the wind. By each attraction of the magnet the pen is displaced laterally, first ten times to the left, then ten times to the right; when, therefore, the pen has completed its to-and-fro movement and returned to zero the wind has traveled 10,000 metres. With this instrument endless bands of paper or rolls for a week can be employed, which are divided into hours by the clock causing the three pens placed in the front of the instrument to mark across the paper. The division for the indications of the anemometer is made beforehand. The registration is made very legibly in ink by means of glass pens which are claimed to have been invented in 1887 for this apparatus, though they closely resemble the pens which have been used by Dr. D. Draper, of New York, since 1874 in his registering meteorological instruments.

The baro-thermometrograph shown was a combination of the balance barograph and the balance air thermometer with sliding weight, on Dr. Sprung's principle. The tube of the barometer is suspended from a balance and as the mercury rises or falls, and in consequence the tube becomes heavier or lighter, the escapement of a clock movement is liberated and displaces the weight on the balance beam until this is in equilibrium, when the wheels are stopped. The pen follows the motion of the running weight and thus traces a line which corresponds to the varying height of the barometer. The air thermometer is composed of a large glass reservoir connected by a very small tube with the top of a barometer tube whose mercury oscillates with the temperature changes of the rarefied air in the reservoir. The height of the mercury column does not exactly indicate the temperature, for the mercury is also subjected to the atmospheric pressure. To neutralize this influence the barometric tube forms part of the apparatus, the tube of the registering barometer and of the air thermometer having the same diameter. When the atmospheric pressure changes, the same quantity of mercury flows from each of the tubes into the buckets placed below and suspended to the ends of an equal-armed balance. This balance, therefore, remains in equilibrium with a change of atmospheric pressure, but if a change of temperature causes the mercury to flow out of the thermometer tube the equilibrium is destroyed and the running weight is displaced with the result before described. The paper can be made to last any desired time, the division into hours being done by the clock and the registration effected in ink. A grand prize was awarded to Mr. Olland.

In the Russian section J. Timtchenko exhibited an anemograph, illustrated in Fig. 22, for which he claimed the originality of registering by a single symbol upon a revolving drum both the direction and velocity of the wind. Though this claim can not be sustained, since the principle of registering the direction and velocity by an arrow is used in other anemographs, yet the mechanism of this one is compact. The spindle, *a*, of the vane, consisting of a fan-wheel on a horizontal axis, descends into the observatory and carries a disk, *e*, divided

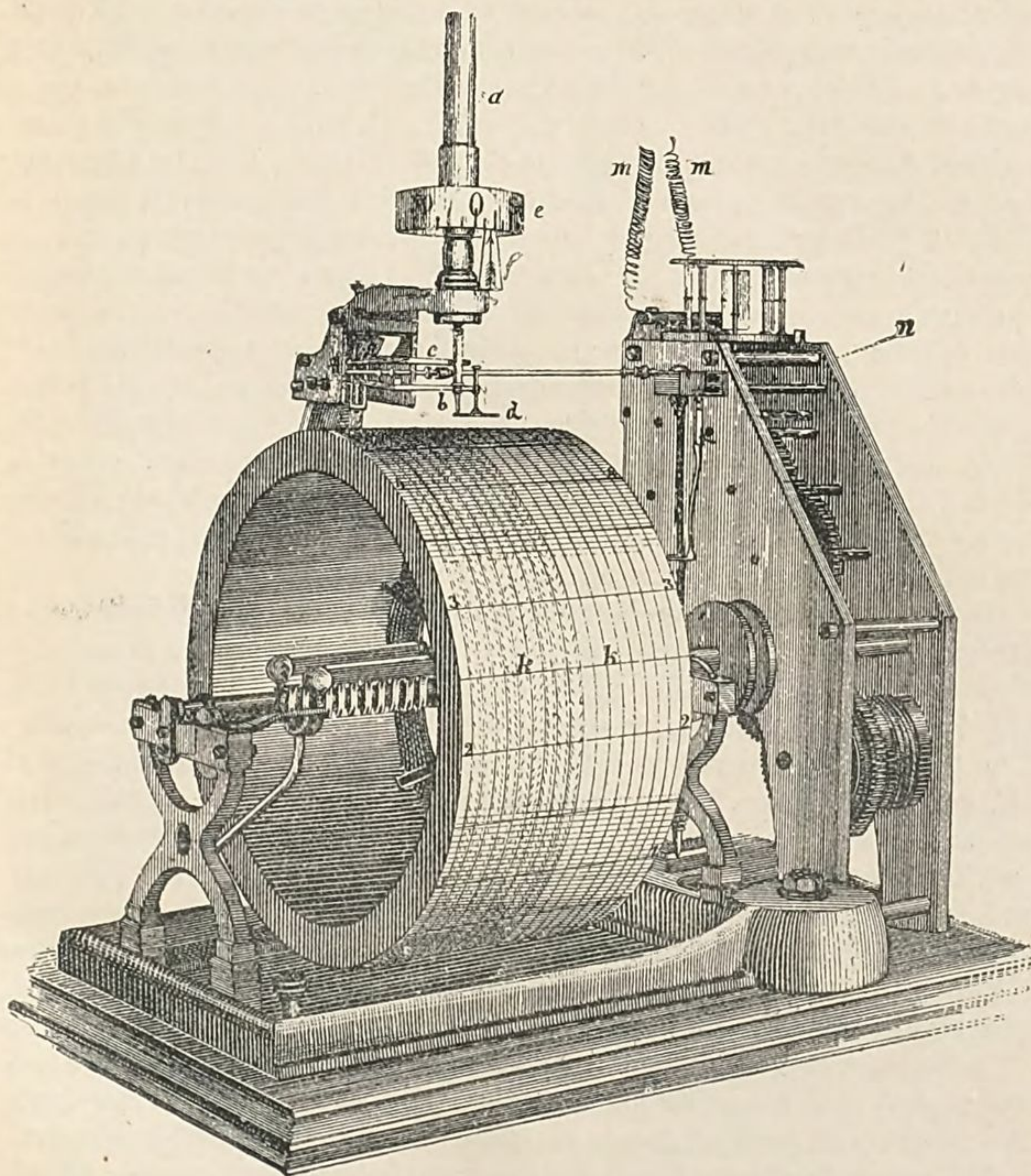


FIG. 22.

to the points of the compass, which permits the direction of the wind to be read directly from a fixed index, *f*. On the end of this spindle is a hollow cylinder, *b*, having an engraved arrow, which is sustained by a fork, *c*, and also rests on a cloth-covered disk, *d*, saturated with ink. Beneath is a drum, *k k*, turned on its axis by clockwork once in twelve

hours and covered with paper, which is divided by transverse lines into hour and half-hour periods and by longitudinal lines into twenty-four hours. During twenty-four hours the drum makes two revolutions, and by means of a screw has a progressive movement which advances it on its axis during sixty-four turns, so that the clock need be wound up only each thirty-two days. The anemometer has Robinson cups, which complete an electric circuit through the wires, *mm*, for each one hundred revolutions, and by means of the action of an electro-magnet at *n* upon a system of levers and eccentrics the ink disk turns aside, the cylinder falls on the paper and imprints the arrow indicating the wind direction. This done, the cylinder rises and the ink disk comes again under its extremity. The length of contact depends generally upon the wind velocity, but the registering mechanism is so constructed as to make but one turn independently of the length of contact, always employing the same length of time and imprinting but one arrow. The apparatus being oriented, the arrow printed on the paper will indicate the wind direction, and the number of these arrows recorded in a space representing one hour gives the data for determining the wind velocity from a table prepared when the Robinson cups are tested. The anemograph costs \$400, and it is apparently in use at the Odessa Observatory, since a description has been prepared by Professor Klossovsky of that institution. A pluviograph, with no description of its action, was shown by the same constructor, who received a silver medal.

Two curious thermometers were to be seen in the Russian and Grecian sections. The first was the rotative maximum and minimum thermometer of L. Rabinowitch, which has a hollow jacketed bulb filled with alcohol and a stem bent into a circle containing mercury. The thermometer revolves in a frame about an axis on the bulb, and the end of the stem which forms the index moves over a graduated arc and marks by means of two movable indices the amplitude of its oscillations, which is determined by the change of center of gravity due to the movement of the mercury in the tube. This somewhat resembles Kreil's thermograph, in which a thermometer is balanced on a knife-edge. For this and other devices a gold medal was awarded Mr. Rabinowitch. The pocket thermometer for which H. Pieroni, of Athens, received a silver medal has a curved bimetallic bar fixed at one end, and connected at the other with a sector, which, through the medium of a coiled spring, actuates a needle on a dial graduated to Reaumur degrees. The whole is contained in a silver coin about the size of a silver dollar, and is sold for \$6. The motor and transmitting mechanism resemble those of the thermograph manufactured by the Draper Manufacturing Company of New York. As a pocket instrument it is larger and less sensitive than the English clinical thermometer of Immisch, whose motor is a curved tube filled with alcohol with one end free to move.

Two registers for a tide gauge and barometer, on the principle of Dr. Sprung's barograph, were exhibited by J. A. Neergaard, of Copenhagen, who received a silver medal. A combined water bottle and deep-sea thermometer, also the invention of Capt. G. Rung, of the Danish Meteorological Office, was unfortunately not seen by the jury of Class 15, but a gold medal was awarded him as collaborator. In this apparatus, shown in Fig. 23, when the bottle, *f*, reaches the desired depth in the ocean a running weight, *v*, is sent down the line. This, by releasing a catch, *k b*, causes the bottle to invert and the plunger, *r*, being drawn up, to fill with water through the orifice, *p*,

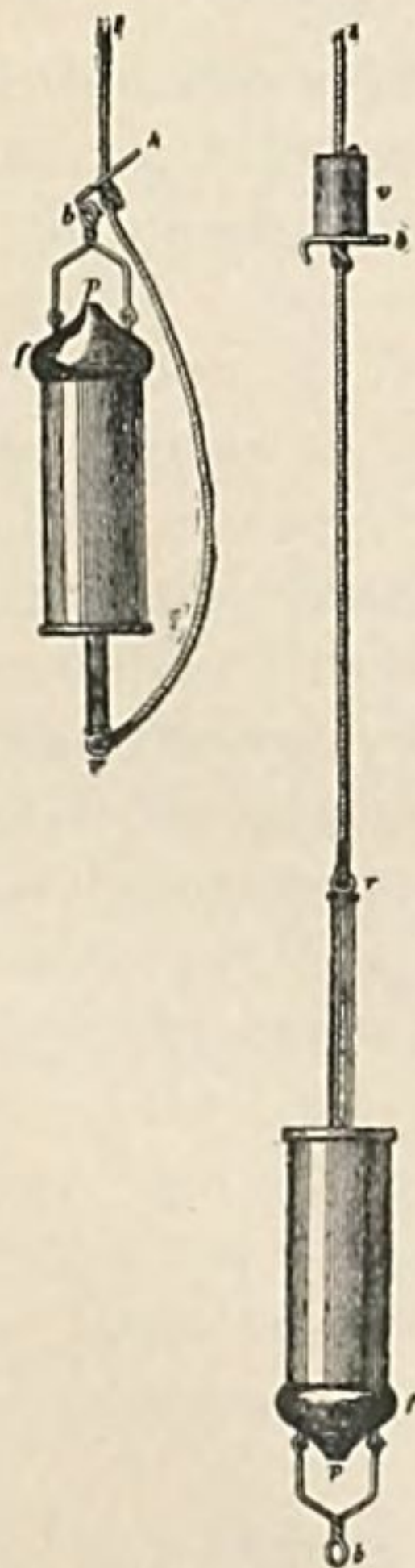


FIG. 23.

while, at the same time, a turnover thermometer of Negretti & Zambra, whose bulb had previously projected below the bottle, is likewise inverted, as seen on the right, thereby registering the temperature. A sample of the water and its temperature where collected are thus obtained when the apparatus is brought to the surface.

The pavilion of the Principality of Monaco contained an interesting collection of apparatus used in the scientific cruises of the yacht *Hirondelle*, in which two instruments of Richard Brothers figured. The first served to register the penetration and intensity of light in the ocean. It consists of a cylinder, turned on its axis in twelve hours, and hermetically inclosed in a metallic box, in whose cover a slit with red glass, increasing in color intensity from one end of the slit to the other, permits the light to act to a greater length

on the sensitized paper which covers the cylinder in proportion as the light is stronger. At Madeira this apparatus showed that at a depth of about 34 metres no light penetrated. A thermograph contained in a similar box, connected by a capillary tube with a cylindrical reservoir containing alcohol and exposed to the water, was used to register the range of temperature of the ocean. Such an instrument, submerged in the harbor of Havre showed that during a week in July the water temperature varied only from 14° to 15° C., while that of the air ranged from 10° to 41° C. In one week of January the water temperature fluctuated between 7° and 9° , while the extremes of the air were -6° and 4° C. In order to establish equilibrium between the inside and the outside of the boxes containing these instruments when sunk in the water, an ingenious device was applied by Dr. Regnard, which consists of a rubber balloon filled with air, and communicating with the box. When both are submerged, the balloon is compressed as it sinks, and a quantity of air exactly equal to the pressure to which it is subjected is forced into the box. There is thus the same interior and exterior pressure on the box, and, consequently, no compression even at great depths.

In concluding this review of the meteorological exhibits at the Paris Exposition of 1889, we can not but be surprised at the number and variety of the instruments of precision which have been applied to the study of meteorology, and yet, judging from the new lines of research which are constantly being opened, we can not doubt that instrumental meteorology is still in its infancy.

PROCEEDINGS OF THE INTERNATIONAL METEOROLOGICAL CONGRESS,
AND OF THE INTERNATIONAL HYDROLOGICAL AND CLIMATOLOGICAL
CONGRESS, HELD AT PARIS DURING THE EXPOSITION.

Reported by A. LAWRENCE ROTCH,

*Delegate appointed by the United States Commissioner-General to represent the
United States.*

THE INTERNATIONAL METEOROLOGICAL CONGRESS.

An International Meteorological Congress was held at Paris between September 19 and 26, 1889. The meetings took place at the rooms of the Société d'Encouragement, except the opening and closing sessions which were at the Trocadéro Palace. There were no delegates appointed by either Germany or Austria for political reasons, and Russia, Holland, Belgium, etc., were also unrepresented, but, on the other hand, there were present delegates from such distant places as Japan and the South American states. The Congress, being an unofficial one, had no power to make resolutions or recommendations, but the suggestions resulting from the papers and discussions will no doubt have their effect upon the directors of the meteorological services and observatories who attended the Congress.

Mr. Mascart, the director of the French Meteorological Office, welcomed the members of the Congress in the name of the minister of Public Instruction and declared the Congress open. The following officers were then appointed:

President: Mr. Renou, president of the French Meteorological Society and director of the Park of St. Maur Observatory.

Vice presidents: Rev. Fr. Denza (Italy), Messrs. Symons (England), Hildebrandsson (Sweden), Billwiller (Switzerland), Paulsen (Denmark), Pujazon (Spain), Cruls (Brazil), and Gould (United States but formerly in the Argentine Republic).

General secretary: Mr. Léon Teisserenc de Bort.

Secretaries: Messrs. Moureaux, Lasne, Abbé Maze, and Mr. Lancaster, of Belgium, who was absent.

The president in his opening address spoke of the natural division of meteorology into statical and dynamical meteorology both of

which could profit by the reunion of a congress—the first in climatology, for which a uniform method of observation was necessary, the second in weather prediction, for which the coöperation of a network of stations should be sought for.

Mr. Mascart presented a copy of the International Meteorological Tables, published under the auspices of the International Meteorological Committee by the resolution of the Roman Congress. These tables have their headings in French, English, and German, and will be sold at 35 francs a copy. They have since been distributed to subscribers.

The sessions of the Congress for the discussion of the programme which had been prepared were presided over successively by the vice presidents, with two exceptions. Mr. Hildebrandsson commenced the programme by presenting a report on the classification of clouds, which had been printed and distributed to the members of the Congress. The classification reduces the number of forms to the ten following:

CIRRUS.

Cirro-cumulus.	Cirro-stratus.
Cumulo-cirrus or alto-cumulus.	Strato-cirrus or alto-stratus.
Strato-cumulus.	Nimbus.
Cumulus.	Cumulo-nimbus.

STRATUS.

Mr. Hildebrandsson showed a series of cloud photographs executed at Upsala, and a series of oil paintings made in Sweden and at Hamburg in accordance with his classification and that of Mr. Abercromby. These paintings will soon be reproduced by chromolithography. In a discussion of this report the Abbé Maze proposed another radically different classification, designating the clouds by two words expressing the kind and species.

The Rev. Fr. Denza communicated a memoir on the vertical decrease of temperature in Italy. The mean for the year gave for a decrease of 1° C. 192 metres for the whole of Italy, but in the Aoste Valley only 159 metres. In winter the figures were 289 and 189 metres respectively, which latter coincide with those found between Pike's Peak and Denver, which are 187 metres for winter and 159 metres for the mean of the year. The difference of level of the stations in the Alps is 2,200 metres and in Colorado 2,700 metres. It often happens that up to a certain height the air temperature rises and then diminishes. This effect is most noticeable in winter, and has never been more marked than in January, 1887, when the temperature at 700 metres was 7° C. higher than at 200 meters, above which it decreased at the ordinary rate. During this month the ground was covered with snow, the barometric pressure was high, and the air was

calm and dry. The author concluded that the problem was complex for mountainous regions and that more observations were necessary. In the discussion which followed it was pointed out that there should be a distinction made between observations during calm and during windy weather, and in the last case whether the wind ascended or descended the mountain flanks; also the wind direction at each station should be noted, for if the directions are different the results of the comparison are doubtful. Mr. Billwiller said that the diminution of temperature differs for neighboring localities, and doubtless depends on the configuration of the ground, and that therefore no absolute relation can be established between the altitude and the range of the variation. The temperature of the valleys must in any case be left out of account. The law depends upon the manner of choosing the station, but in winter the question is simpler because there is less stagnation, and as soon as the air is in motion the law of the decrease is established.

Mr. Wada gave the results obtained by ascents of Fusi-yama in Japan. In August, 1880, simultaneous observations at the top of this mountain (3,700 metres above sea level) and at its foot gave a decrease of temperature of 1° C. for 182 metres, or 0.55° for 100 metres vertical elevation; this number appears smaller than it should be, because the observations, which lasted three days, were made only during the daytime. Another ascent, made in September, 1887, gave a decrease of 1° for 168 metres, or 0.59° for each 100 metres. It is proposed to make an ascent of Fusi-yama every year for physical experiments.

Rev. Fr. Dechevrens said that the question of variation of temperature with altitude had a particular interest when considered with regard to the variation of atmospheric pressure. Thus he had shown that if with high pressures the temperature is relatively very high on the mountain summits and very low in the valleys and plains, the inverse occurs with low pressures. In brief, the approach of a cyclone produces heat in the lower strata of the atmosphere and cold on the mountains, just as the approach of an anti-cyclone produces the reverse phenomena. These phenomena do not depend on the wind direction as has been supposed. Thus at Zi-Ka-Wei, in China, in the midst of a vast plain, from whatever quarter the wind came, when the barometer fell there was almost always a rise of about 10° for a fall of 20 millimetres in the pressure. On Mount Washington, on the other hand, where the northwest wind blows almost constantly, an equal fall of the barometer brings generally a fall of nearly 30° in the thermometer. This phenomenon should find an explication in any rational and complete theory of atmospheric cyclones.

Mr. Adam Paulsen communicated the results of measurements in Greenland on the elevation of the auroræ boreales above the ground,

obtained by means of two theodolites on a base of 5,800 metres. Measures in temperate regions have given a height of 200 kilometres and more, but here it was found that the auroræ descended sometimes to within 600 metres of the fiord, but at other times rose to 60 or 70 kilometres. It is thus shown that though the height of auroræ is very variable, there is no stratum particularly favorable for their formation. It results from the comparison of the tables of frequency of auroræ with those showing the frequency of sun spots during the same periods, that the maximum frequency of auroræ corresponds to the minimum of solar activity, while in temperate regions precisely the opposite occurs. In the same way the amplitude of the diurnal variation of the magnetic needle in temperate regions increases with the number of sun spots, while, according to the author, the contrary occurs in the polar regions, so that the parallelism between auroræ and the magnetic needle obtains in all latitudes.

Mr. Teisserenc de Bort presented, on the part of M. Cérasky, a notice of the luminous clouds seen at Moscow in 1885 and 1886. The height of these clouds was approximately determined to be 75 kilometres. These clouds owed their light to the sun, and were only seen when the sun had descended a little below the horizon. They were absolutely transparent, but were sufficiently luminous to be photographed. The coincidence between their disappearance and that of the sky glows was remarked. The variations of actinometric measurements, even when the sky was clear, have led Mr. Crova to admit the presence from instant to instant of thin veils invisible to the eye, and photographs of a very blue sky have shown fine striæ, analogous to cirri, which were quite invisible otherwise.

At the second meeting Mr. Angot discussed the first comparative observations of wind velocity on the summit of the Eiffel Tower and at the Central Meteorological Office. Up to the 31st of August, 71 days of observations gave the following results of the diurnal variation of the velocity: At each station the diurnal curve showed a chief maximum and a chief minimum; at the Meteorological Office the minimum (1.5 metres per second) occurred about 4:30 a. m. and the maximum (3.2 metres per second) about 1 p. m., this being the ordinary variation at low stations. On the summit of the Eiffel Tower, on the contrary, the minimum (4.9 metres per second) was a little before 9 a. m. and the maximum (9 metres per second) occurred toward 11:30 p. m., which resembles the régime of the wind on mountains. The relation of the velocities was at its maximum, 5, from 2 to 4 a. m; it was at its minimum, 2, from 9 a. m. to 3 p. m. It is interesting and wholly unexpected to find at 300 metres above the ground the diurnal variation in wind velocity which hitherto has only been observed on high mountains.

Mr. Hepites described the organization of the recently established Roumanian meteorological service, and the Rev. Fr. Denza made

some general deductions from tables showing the mean monthly and annual temperatures at Italian stations. Mr. Sieur considered the secular changes of climate, and sought to refute the arguments explaining the variations of temperature by the displacement of perihelion. In the discussion which followed it was the general opinion that no secular variation of climate could be inferred from the limits of forests, vineyards, or glaciers, the dates of the freezing of lakes and rivers, and the time of harvests, or from the temperatures of thermal springs.

Mr. Symons exhibited and explained his new instrument called a brontometer, constructed by Richard Brothers. This is a registering instrument permitting the time of the lightning, the beginning and ending of the thunder, rain, and hail to be noted by means of keys. The instrument records automatically at the same time the smallest variations in the barometric pressure and the velocity of the wind, and it is expected that it will be of much value in studying the cause and relation of the various phenomena of a thunderstorm.

Mr. Teisserenc de Bort showed some remarkable cloud photographs of Mr. Paul Garnier which are the result of much experimenting with the various photographic apparatus and plates.

At the next meeting Mr. Rotch described the apparatus employed at the Blue Hill Observatory for measuring the movement of clouds and for registering the cloudiness during the night. A description of the nephoscope and of the methods employed in the former work will be found in volume XX, *Annals of the Observatory of Harvard College*. To register the cloudiness during the night an apparatus invented by Professor Pickering is employed, consisting of a photographic camera with very sensitive plates directed to the pole star. An automatic shutter closes the camera before dawn. If the night is clear the trace of the pole star is represented by an arc of a circle, which is broken when clouds pass before the star. These interruptions measure the cloudiness, and the results obtained do not differ a tenth from the means of direct observations.

Mr. G. Lemoine described the progress accomplished since 1878 in the chief river basins of France with respect to flood warnings. The administrative organization directed by a commission has become quite general, while the technical studies pursued in the various basins result in flood warnings which are in some cases given four days in advance.

The Congress expressed the wish that in each state the system of pluviometric and hydrometric observations should be extended as much as possible by the proper authorities in order to permit a more complete study of precipitation, the extreme and mean discharge of streams of water, and the influences which modify their relations.

Mr. Ritter explained a mode of notation by which the absolute in-

tensity of a phenomenon was indicated by a coefficient *meteorograde*, representing the relative degree of intensity of this phenomenon, or the relation which its actual intensity bears to its maximum intensity in the place under consideration. Mr. Ritter exhibited some charts, constructed after his method, of hydrological phenomena, and suggested its application to the variation of the barometer.

The Abbé Maze elaborated his binary cloud classification modeled after the classification of Linneus, which is used by naturalists. Mr. Hildebrandsson replied that in advocating with Mr. Abercromby a modification of Howard's cloud classification he acted from a practical point of view, and said that it was unwise to burden the memory of observers with a complicated nomenclature. The Rev. Frs. Ferrari and Denza sustained Mr. Hildebrandsson.

Mr. Teisserenc de Bort defined the difference between the origins of barometric gradients, showing that the gradient could generally be resolved into two parts—the motor gradient which caused the motion and the resisting gradient which is a consequence of the movement, and which only acts to balance the action of the centrifugal force. He stated that this distinction between the gradients in a barometric depression had a practical importance in weather prediction.

Mr. Symons showed two photographs of lightning flashes taken by Mr. Weber on a plate moved laterally. The trace was indicated by a band instead of by a network of discharges, proving that the duration of the flash is quite appreciable.

At the following meeting Mr. Cornu described his photo-polarimeter as we have already done in the account of Pellin's exhibit at the Exposition. The use of this instrument, which gives exact indications on a scale of 100, was recommended to meteorologists, since it had been found that the sudden change in polarized light corresponds always to a marked change in the meteorological conditions, and this before the other atmospheric phenomena give any signs of a change.

Mr. Raulin presented a memoir on rain periods. Like the mean temperature, the evaporation follows a certain seasonal law, and the precipitation gives a similar curve when the means of a long period are used. For continental climates the curve has about the same form as that of the temperature, but in approaching the coast the curve becomes almost the inverse of the temperature. Charts were shown in which the regions under these régimes were distinguished by different colors.

Mr. de Montessus stated the results of his investigations on the diurnal distribution of seismic shocks and their pretended relation to lunar phases. For this purpose he compared 45,000 seismic disturbances distributed over the globe. There is a faint maximum during the night, but this disappears when the stronger shocks are consid-

ered. The distribution throughout the phases of the moon is nearly uniform, and the author hopes to be able to demonstrate that the seismic disturbances are independent of exterior influences. Mr. Wada remarked that the observations made in Japan gave entirely contrary results to those of Mr. de Montessus, as it was shown by more than ten years' observations that the earthquakes were more frequent during the night than during the day and that there was a slight increase during the interval from the last quarter to the new moon over the number during the other quarters.

Mr. Angot read a report on the observations of vegetative phenomena, the migration of birds, and the appearance of insects, with a view to arrive at uniformity in the instructions given to observers, especially in regard to the notation. Mr. Teisserenc de Bort read a report by Mr. de Touchimbert on the quantity of heat necessary to bring wheat to maturity at Poitiers. In the discussion which followed, the local influences of topography on temperature were quoted.

Mr. Sieur presented a paper on the tracks of fourteen thunderstorms in southwestern France. He spoke of the influence of valleys and water courses upon the direction of storms, and remarked their appearance in series having nearly parallel paths.

Lieutenant Ward, U. S. Navy, exhibited charts and logs of the U. S. Hydrographic Office, and stated that this bureau is prepared to receive, publish, and distribute speedily all meteorological data which are sent to it, in a useful form for navigators and meteorologists. The office is also ready to furnish its information to any other office which desires to coöperate with it. Regret was expressed that the series of international observations, organized by the Vienna Congress of 1873, should have been abandoned. The aid of the Congress was asked to supply information which might assist in the preparation of meteorological charts of the seas south of the equator, a work soon to be undertaken by the Hydrographic Office.

On the afternoon of the 24th, Mr. Moureaux read a paper by Mr. Ellis, of Greenwich, on the relations existing between astronomy, meteorology, and terrestrial magnetism. Most astronomical observatories are provided with accurate and powerful apparatus, and their number is sufficient for the actual needs of the science. In meteorology, on the contrary, a great number of observatories are necessary, and the united action required justifies the reunions of congresses. Magnetic phenomena being of a more general nature, it is not necessary that the observatories should be numerous if well distributed. Mr. Ellis mentioned the relation of magnetic phenomena to sun spots, and stated the following desiderata: (1) The establishment of permanent magnetic observatories in regions where they are lacking, especially in the southern hemisphere; (2) the exact registration of the time on the magnetic curves; (3) the publication by the different observatories of a certain number of curves of perturba-

tions on days to be agreed upon ; (4) the development of the theory of earth currents which are in close relation with the irregular variation of magnetic phenomena. Mr. Moureaux stated how far these conditions were fulfilled in France and the colonies, and Mr. Mascart explained why the short magnets employed in the French magnetographs were preferable to the large magnets used in the Adie and other foreign instruments.

Mr. Mazoyer explained the method used in making flood predictions on the Loire. By means of the maximum heights of the water observed at well-chosen points upstream, the maximum flood can be calculated for a point situated farther down, and warnings given by telegraph or special telephone to interested persons.

Dr. Fines stated the results of his comparisons between the Robinson and Bourdon anemometers, from which it appeared that the former always gave a less velocity than the latter, though the mean difference did not exceed 6 metres with a mean velocity of 30 metres per second. Dr. Fines mentioned the importance of indicating the height of the anemometer above the ground in any series of observations, since it has been found that the wind velocity at an altitude of 30 metres is nearly double that at the surface of the ground.

Mr. Renou described the necessary conditions for a good thermometer shelter. A simple roof, inclined toward the south, having a screen of oilcloth stretched a little above and with two lateral isolated screens permitting the free passage of air on all sides, constitutes the best shelter. The thermometers should be placed slightly below its lower edge and controlled by a sling thermometer, especially in the morning and in the evening.

Mr. Dufour exhibited a new condensation hygrometer in which the dewpoint is determined in the plate of silvered brass on which the dew is deposited. The simplest form is a polished bar with a thermometer inserted in each end and provided with a graduated scale. One end being cooled by dropping ether upon it, the position of the limit of the dew is noted and the corresponding temperature is obtained by interpolation from the readings of the two thermometers.

At the next meeting Mr. Piltschikoff, after citing the anomalies presented by the isomagnetic lines experimentally determined in Europe and America, insisted upon the importance of a theoretical study of these lines and their variations. He explained a graphic method of obtaining the diagrams of the various isomagnetic lines corresponding to a unipolar anomaly. In answer to Mr. Gossot, Mr. Mascart said that although the relations between the position of the sun or the planets and magnetic phenomena had long been sought, these relations were absolutely fanciful, which opinion is now universally held by meteorologists.

Mr. David presented a note on the employment of semaphores for the dissemination of local weather forecasts in the department of the

Yonne. Mr. Hildebrandsson explained the system employed in Sweden to transmit the weather conditions by means of 114 charts of weather types, which are numbered, and complete sets distributed to the railway stations and ports. It is, therefore, only necessary to telegraph the number of the proper chart to have the corresponding signal displayed.

Mr. Poincaré gave a résumé of his researches on the relations between the positions of the moon, the displacement of the limits of the trade winds, and the barometric changes. The displacements of the region of the trades for two years were found to be proportional to the amplitude of the lunar oscillations, and the passage into perigee or apogee was accompanied by barometric changes whose combination produced a sudden fluctuation of a millimetre in the gradient, and corresponding oscillations in the trade-wind limits.

Mr. Billwiller stated the theory of the diurnal variation of the wind at elevated stations which was first suggested by Espy, elaborated by Köppen, and confirmed by the observations made in 1883 on the Säntis.

Mr. Lasne developed his theory of the gyratory movements of the atmosphere, which he had already laid before the French Meteorological Society. He supposes that these movements have a general dynamic and not a local thermic origin, and that they are due to the lateral friction of the permanent winds situated at a great altitude.

The Rev. Fr. Dechevrens presented a note on the observations of the inclination and of the vertical component of the wind at Zi-Ka-Wei, China. They show that at a height of 40 metres the general movement of the air is upward at an angle slightly exceeding 6° . During the day the direction of motion is very variable, but during the night the wind always ascends, and more strongly in winter than in summer. If the inclination of the wind in winter be compared with the corresponding barometric heights, it is seen that the movement of the air is clearly upward during the barometric depressions, and as a general rule the velocity is greater as the barometer is lower. It was remarked that the curve representing the mean variation of the wind at Zi-Ka-Wei in 1886 was exactly the reverse of the curve of the variation of the atmospheric electricity at Perpignan. The Rev. Fr. Dechevrens described the apparatus successfully used by him, and proposed now to replace the cup anemometer, which gave neither the horizontal component nor the absolute value of the wind velocity, by one having vertical semicylinders upon which the vertical component of the wind could have no action.

At the following meeting Mr. Raulin considered the rain periods for South America and divided them into seven seasonal types. Mr. Wada presented a study of thunderstorms in Japan based on the documents of the Tokio Observatory since 1875 and upon the recent

data from thirty-five stations of the second order. The results show that the frequency of storms increases toward the north, and seem to indicate that the frequency is also greater in the interior and in elevated regions than on the coast. The damage by lightning and hail is less in Japan than in Europe on account of the light and low form of the buildings, but nevertheless the Government is about to require industrial buildings to be provided with lightning rods under the supervision of the telegraph department.

The Rev. Fr. Dechevrens stated that in Japan he had found a maximum in the spring and a more marked one in the autumn; in China, a single summer maximum with no winter storms; at San Fernando, two nearly equal maxima in the spring and autumn, and on the Congo, from one year's observations, the autumn maximum less than that of the spring. The curve of the frequency of cirri presents the same form for different localities. Mr. Hildebrandsson had found in Germany a secondary maximum in the spring and a chief maximum in the autumn; in the north of Sweden there is a prolonged maximum in the summer, while in the northern part of the country the thunderstorms are confined to the warmest months. He had not remarked the concordance of the cirrus. Mr. Mascart remarked that in France as in Japan the severity of thunderstorms increased inland.

Mr. Wada proposed a uniform system of storm signals, similar to the Japanese, for international adoption. On motion of Mr. Mascart, the Congress expressed the wish that the system of storm signals should be rendered uniform as speedily as possible, and referred the question to the International Maritime Conference in session at Washington.

Mr. Teisserenc de Bort gave a résumé of his memoir on the distribution of barometric pressure over the globe. The equatorial minimum observed is easily explained by the difference of temperatures, but the cause of the tropical maximum is not so clear. Ferrel has stated the effect of the relative movement, but the author's theory of the annular barometric maxima differs in believing that the causes alleged by Ferrel only act to increase the maxima. In their relative motion with respect to the ground the winds thus created outstrip the latter's movement and describe a curved path, the velocity being reduced by friction in the ratio assumed by the author to be the square root of the calculated velocities. In its movement toward the poles the air meets parallels where the value of a degree of longitude becomes smaller and smaller, whence results the accumulation of air which causes the polar maximum. The author has calculated the form of a surface of equal pressure at a height of about 4,000 metres, and knowing the temperature of the lower strata it was easy to calculate the barometric pressure at the surface of the earth. The isobars drawn with these data agree fairly with the observed isobars, thus demonstrating the truth of the theories set forth.

Mr. Hildebrandsson said he had observed the mean direction of atmospheric currents, independently of any theory. He had recognized in the neighborhood of depressions a convergence of the winds at the earth's surface; from 2,000 to 3,000 metres the movements are nearly circular, and in the cirrus region the motion is always divergent. His work, together with that of Mr. Ley, permitted him to establish wind roses for almost all the countries of the world. The data embodied in two charts, one for summer the other for winter, showed that the cirrus moves toward the west in equatorial and toward the east in temperate regions. In the north of Europe a slight deviation toward the southeast is remarked in winter. The cirri thus appear to follow the same paths as the great barometric depressions. Mr. Hildebrandsson exhibited the nephoscope of Fineman adapted for use on board ship.

Mr. Lasne remarked that the vertical movements of the air observed by the Rev. Fr. Dechevrens were incompatible with the horizontal wind velocities noted, which must, nevertheless, furnish the supply or escape of the necessary air. The Rev. Fr. Dechevrens replied that he did not think that the heating and cooling of the tower exerted any influence, since he observed generally the descending movements during the day and the ascending ones during the night. Vertical currents also occurred when there were no horizontal winds. These facts were independent of any theoretical considerations.

Mr. Teisserenc de Bort presented, on the part of Mr. Renou, a note relating to the uniform notation of fog, days with rain, etc. At the Park of St. Maur the term fog is used when objects are hidden at 15 metres. The last meteorological congress recommended that rainy days should be those on which at least 0.5 millimetre fell, but the author considers that the moistening of the pavement is sufficient evidence for the purpose. In the days with thunderstorms he would also include those on which the faintest thunder was heard.

Mr. Richard described an aspiration anemometer recently installed at the Paris Meteorological Office on Hagemann's principle, consisting of a vertical tube terminated by a truncated cone which is open at its smaller base. The aspiration produced by the wind in this apparatus is registered by means of a very sensitive manometer. Dr. Fines described a modification of the Hagemann anemometer in which the effect of the wind was increased.

At the closing session of the Congress Dr. Fines presented a note on the variations of atmospheric electricity observed at Perpignan, alluding also to the difficulties caused by spiders' webs on the collector and the effect of humidity on the suspension of the needles of the magnetometers. Mr. Moureaux described the methods employed in the last instance at the St. Maur Observatory. The discussion of the curves of atmospheric electricity at the Collège de France shows the third oscillation toward the middle of the day

mentioned by Dr. Fines, but it is not found at St. Maur and it is nearly insensible at Lyons. At the latter station the absolute minimum occurs in the morning instead of in the evening as at all the other stations whose observations had been discussed. Mr. Mascart observed that the potential of the electrometer is especially influenced by the masses of air which touch it, and that its indications depend upon the objects over which the wind has passed. He had replied to those persons who wished electrical observations made on the summit of the Eiffel Tower that, notwithstanding its height, the difference of potential between the top and the ground was zero.

Mr. Teisserenc de Bort presented a note, on the part of Mr. Piche, formulating a new meteorological law. The author supposes the sun's heat to be constant and to be distributed between the atmosphere which it sets in motion, human beings, animals, and plants. Thus, if one of these modes of utilizing this heat be increased, the others will necessarily be diminished, so that if man could favor the development of organic life the heat available for putting the air in motion, and consequently storms, might be decreased. In a discussion which followed on the possible influence of man on climate it was the general opinion that the effect could only be local or indirect.

Mr. Rotch read in abstract a paper by Mr. Clayton upon the classification of clouds according to the general system of Abercromby and Hildebrandsson, but with special reference to their origin.

Mr. Moureaux spoke of the development of magnetic studies in France since the establishment of the Central Meteorological Office. There are now in France ten magnetic observatories, at eight of which the variations of the various elements are continuously registered. The magnetic charts of France, based on the observations of Mr. Moureaux at more than eighty stations, having shown certain anomalies, new and more detailed charts are to be prepared, based on the observations made at the chief towns, at all the ports, and at certain special points indicated by the geological charts. This work will be completed in five or six years.

The Rev. Fr. Denza spoke on the relation of earthquakes and terrestrial magnetism, and Mr. Teisserenc de Bort presented his memoir on the reduction of the barometer to sea level.

Mr. Mascart, on the part of Mr. Renou, who was ill, thanked the members of the Congress, and especially the foreigners, for their hearty coöperation, and congratulated them upon the cordiality and good feeling which had characterized the meetings. The Rev. Fr. Denza replied that although he had heard congresses were useless, yet he believed that they were not only beneficial to the science but to the scientists, who acquired there personal relations with one another which were of great advantage. In the name of all the foreign members he bade an affectionate farewell to the French mete-

orologists, and especially to those who had directed the Congress, which he thereupon declared closed.

The following excursions and visits took place during the sessions of the Congress: On September 20 a visit was made to the Central Meteorological Office, where, in addition to the regular installation, the experimental apparatus of Mr. Weyher to illustrate the formation and action of cyclones, tornadoes, and waterspouts was exhibited in action. The collection of registering instruments of Richard Brothers at the Exposition was inspected the same afternoon. The next day an excursion was made to the park of St. Maur, where the meteorological and magnetic observatories were shown by Messrs. Renou and Moureaux respectively. The Eiffel Tower was ascended on the 25th in order to examine the Richard instruments installed in the meteorological observatory on the top, some of these instruments registering their indications at the ground. On the last day of the Congress the foreign delegates and members were entertained by their French associates at luncheon at a restaurant in the Exposition, and in the evening the principal delegates dined at the house of Mr. Teisserenc de Bort, senator.

THE INTERNATIONAL HYDROLOGICAL AND CLIMATOLOGICAL CONGRESS.

The Congress which met in Paris October 3 to 10, inclusive, 1889, was the outcome of the first International Hydrological and Climatological Congress held at Biarritz in 1886. It was, however, noticeable that many prominent participants in the first congress were absent from Paris, and that the attendance there was far inferior to that at Biarritz. The following foreign governments, through their commissions at the Paris Exposition, sent delegates, viz: Austria, Italy, Spain, Belgium, Roumania, Turkey, United States, Mexico, Brazil, Chili, Bolivia, Japan, and Hawaii.

Mr. Renou, as president of the committee of organization, called the Congress to order in the Trocadéro Palace and made the opening address, after which these officers were appointed:

Honorary president, the minister of the Interior; president, Mr. Renou, director of the Park of St. Maur Observatory and president of the French Meteorological Society; honorary vice president, Professor Winternitz, of the University of Vienna; national vice presidents, Drs. Danjoy, Constantin Paul, and Fines; foreign vice presidents, Messrs. Lancaster (Belgium), Ceccherelli (Italy), and Caldéron (Spain); general secretary, Dr. de Ranse; secretaries, Drs. Schlemmer and De la Harpe.

The sections of scientific and medical hydrology each chose officers, those of the former section being as follows:

President, Dr. Labat, member of the Medical Hydrological Society of Paris; national vice presidents, Drs. Bouloumié and Baréty; for-

foreign vice presidents, Mr. Bonkowsky-Bey (Turkey) and Dr. Poskin (Belgium).

The climatological section was thus officered: President, Mr. Lemoine, chief engineer of the Ponts et Chaussées and vice president of the French Meteorological Society; national vice presidents, Drs. de Valcourt and Hameau; foreign vice presidents, Messrs. Faralli (Italy), Wada (Japan), and Rotch (United States); secretary, Dr. Deligny.

Although the Congress was divided into three sections—scientific hydrology, medical hydrology, and climatology—on account of the close connection between them the sections of scientific hydrology and climatology were united, and for the same reason the three sections sometimes held general sessions, all the sessions being at the School of Medicine. The committee of organization had prepared a series of questions to be discussed, most of which formed the subjects of reports which were previously distributed to members and which served as the basis of discussion. The following are the most important papers presented to the sections of scientific hydrology and climatology: Precautions to be taken in determining the precise temperature of thermal springs, by Mr. Renou. The author in this report described the best methods of observing water temperatures, and called attention to the necessity of using thermometers whose zero points had been rendered invariable. He also explained the proper mode of exposing thermometers for observing air temperatures, as exemplified in the shelter used at the Park of St. Maur. In the discussion which followed, Mr. Wada stated the effect of cyclonic action in influencing the temperature of springs in Japan. According to this speaker the temperature of the springs increased while the volcanic activity decreased before the passage of a barometric depression. An increase in their temperature was also noted before earthquake shocks. Mr. Symons recalled his trip to the Pyrenees, undertaken by authorization of the Royal Society, to verify the temperatures of the thermal springs, which he found had not changed appreciably during the last fifty years.

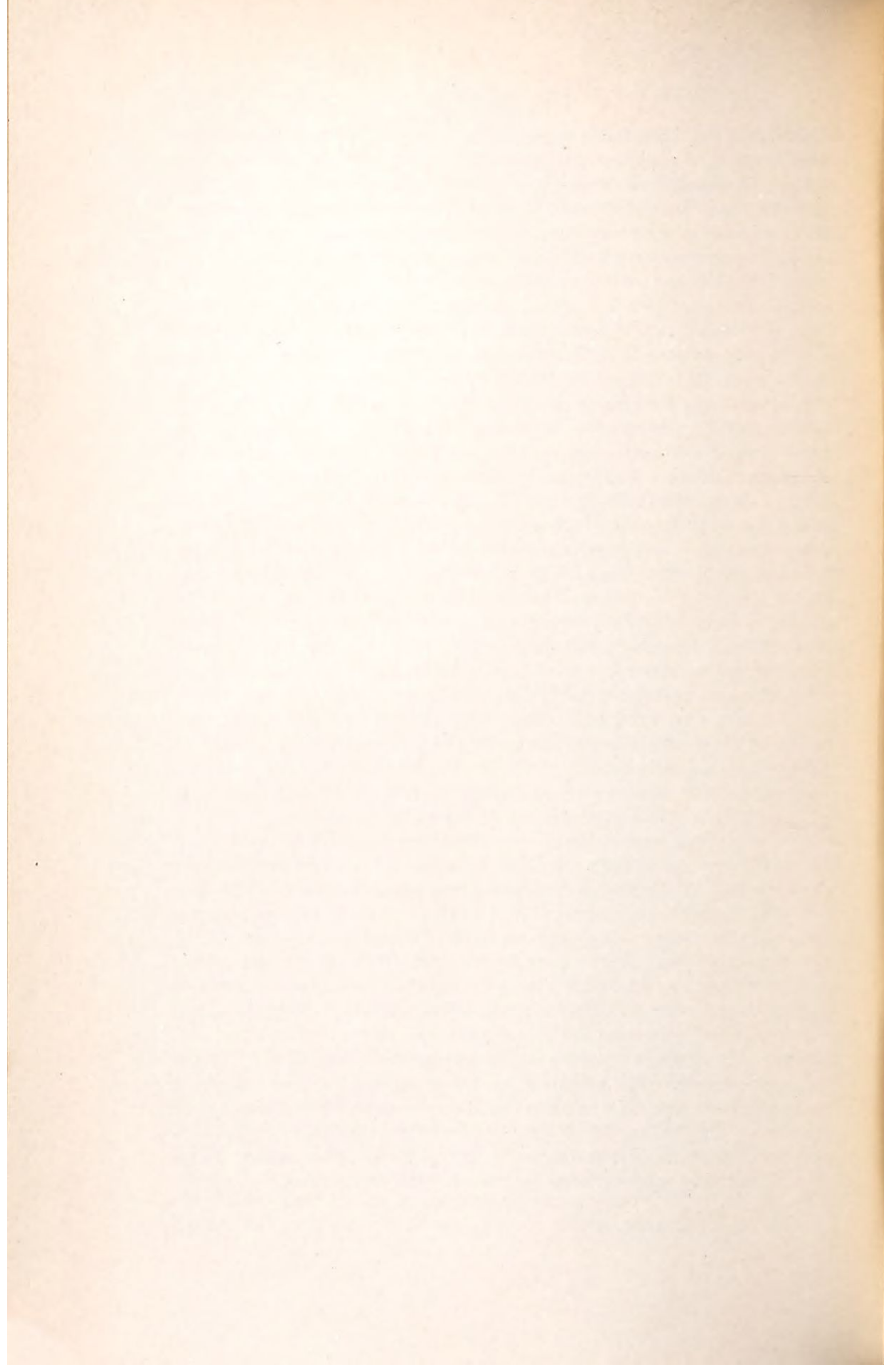
Mr. Lahillonne presented a paper on maritime *vs.* mountain climates, in which he proposed a graphic representation of their peculiarities by two superposed curves, one indicating the temperature, the other the dewpoint. Professor Morales gave an account of the mineral springs of Mexico, and Mr. Guerrerio described the work which he had accomplished at San Fernando, Portugal, to render a large tract of marshy land habitable by planting eucalyptus trees, and thus diminishing the diurnal range of temperature and increasing the humidity. Dr. Labat reviewed his interesting report on the origin of the gases contained in mineral waters, and on the part which they play in the properties of these waters, in which he concluded that no absolute theory of their origin explained all the facts

observed. Dr. Labat also presented a report on the comparison and classification of sanitary stations with respect to their climatic conditions, dividing them from the influence of mountains and sea into mountain and maritime stations suitable for winter and summer. He reviewed the chief health resorts from this point of view, noting their advantages and disadvantages.

Dr. Chiaï spoke of the importance of atmospheric water vapor, which he likened to a protecting mantle, upon the human organism. For each climate the inferior limit of humidity which can be borne without injury should be determined, after which the psychrometer can be consulted by the invalid. Dr. Leudet read a report on the action of high altitudes upon chest diseases, in which he concluded that mountain climates have an incontestable action, very efficacious when it is a question of prevention, but relatively small when it is necessary to cure. Dr. Deligny considered the relations of phthisis to high altitudes, stating that he did not believe that the latter gave immunity from the disease.

Mr. Lemoine submitted to the Congress a provisory programme for a course of climatology which for physicians could be combined with a course of hydrology contained in a dozen lessons. It would consist of two principal parts, the study of the chief meteorological elements and the study of certain climates with some rudimentary ideas of weather forecasting. The meteorological elements considered would be atmospheric pressure, air, and water temperatures, wind, cloud, humidity, rain, and atmospheric electricity. Some attention would be given to the permeability of the soil, and the climates most used by physicians would be studied. Dr. Durand-Fardel's proposed programme for a course of hydrology contained in his report was criticised by Dr. Labat, Professor Winternitz, and others.

At the closing session Rome was chosen as the place of meeting of the next congress in 1892. During the week a number of excursions were made. At Pierrefonds a dinner was given by the municipality and the thermal establishment and chateau visited, as was also the palace at Compiègne. Another day, part of the congressionists visited the meteorological observatory at the Park of St. Maur, the others going to Enghien, where they were shown the thermal establishment and tendered a lunch. Under the guidance of Dr. Labat the pavilion of mineral waters at the Exposition was inspected, and by invitation of Dr. Proust the museum of hygiene of the School of Medicine was visited. The proposed final tour among the hydromineral stations of the Vosges was abandoned on account of the unfavorable weather. On the last day of the Congress the principal foreign delegates were entertained at dinner by Dr. de Ranse, the general secretary, and many international courtesies were exchanged.



THIRD GROUP.

FURNITURE AND ACCESSORIES.

[EXTRACT FROM THE OFFICIAL CLASSIFICATION.]

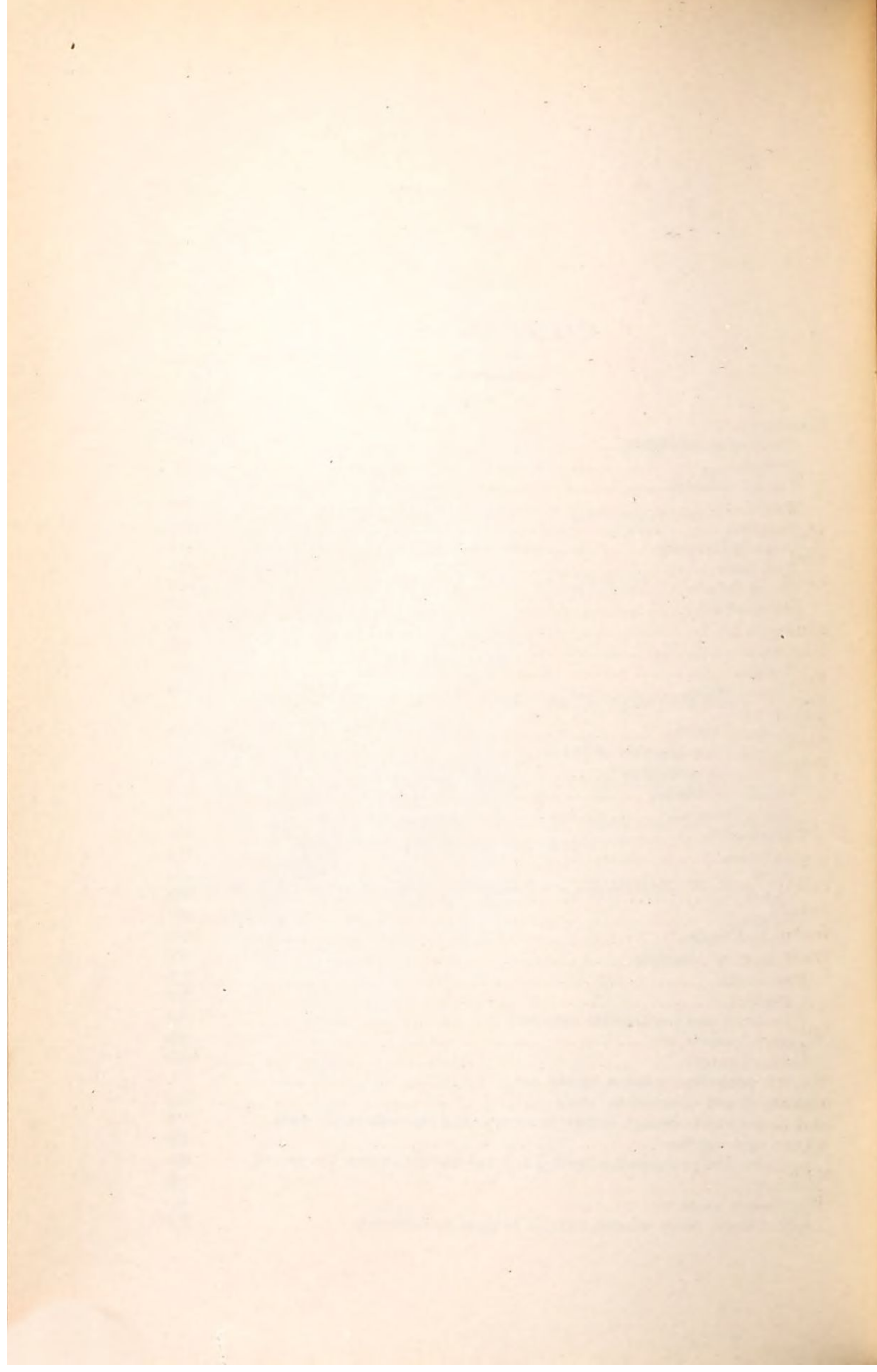
THIRD GROUP.

FURNITURE AND ACCESSORIES.

- CLASS 17. Cheap and fine furniture.
- CLASS 18. Upholsterers' and decorators' work.
- CLASS 19. Crystal, glass and stained glass.
- CLASS 20. Ceramics.
- CLASS 21. Carpets, tapestry, and other fabrics used in house furnishing.
- CLASS 22. Decorated papers.
- CLASS 23. Cutlery.
- CLASS 24. Goldsmiths' and silversmiths' work.
- CLASS 25. Art bronzes and castings. Artistic iron work and repoussé metal work.
- CLASS 26. Watches and clocks.
- CLASS 27. Apparatus and processes for heating. Apparatus and processes for lighting otherwise than by electricity.
- CLASS 28. Perfumery.
- CLASS 29. Leather work. Fancy wooden articles. Baskets and brushes.

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FURNITURE AND ACCESSORIES.

By DAVID URQUHART, Jr.

CLASS 17.—*CHEAP AND FINE FURNITURE.*

CLASS 18.—*UPHOLSTERERS' AND DECORATORS' WORK.*

Many of the objects exhibited under Classes 17 and 18 being partly the work of the furniture-maker and partly that of the upholsterer and decorator, for the general purposes of this report these two classes have been considered together.

The total number of exhibitors was seven hundred and thirty-four, almost two hundred less than at the 1878 Exposition, divided as follows :

France	309	Italy	23
French colonies	78	United States.....	20
French protectorates	45	Other foreign countries.....	168
Japan	53		
Belgium	38	Total.....	734

FRANCE.

Two entire halls were devoted to furniture, along the center of which, on a low platform, were placed the exhibits of a cheap or miscellaneous nature, while against the walls, roofed partitions of the height of ordinary ceilings permitted the most noted French manufacturers to display various articles in an harmonious interior suiting their particular period or the taste of the exhibitor.

The report of the 1878 jury on this industry, while praising the workmanship and skill shown in execution, admits a lack of originality in design.

If in the intervening period newer tendencies have developed, they are not apparent in the present Exhibition, and the general style is, almost without exception, imitative and reproductive of the forms and designs of the time of Henry II, Louis XIV, Louis XV, Louis XVI, and Napoleon I. Even the thirteenth century is revived in some uncomfortable-looking bedroom furniture from drawings of the architect Viollet-le-Duc.

Except in a few instances, where the desire to attract public atten-

tion has led to eccentricity and exaggeration, this copying of old forms has at least been done honestly and faithfully, and the good taste and skillful workmanship characteristic of the French artisan are abundantly shown.

It seems strange that such a high perfection of technical skill, enabling the reproduction in all its details of an article of any period or character, should be content to travel in an old and beaten track instead of seeking new fields more suitable to modern ideas and modern life. And, in fact, there are evidences that progressiveness in this direction is slowly approaching and will be welcomed and rewarded.

Gallé, of Nancy, who exhibited almost the only new and original style of furniture, received substantial recognition from the jury, who bought individually thirty of his tables. The material used by this exhibitor was principally oak and ash, inlaid with natural hard woods of such grain and color as to give the desired effect for a landscape or floral design, etc. In shape his cabinets and tables were rather heavy and square.

There was a large display of walnut "buffets," mantelpieces, etc., polished and stained, and sometimes coated with a peculiar bronze-like varnish. Most of them were of high price, but the carving, though elaborate, was generally dull and spiritless, and by no means equal to the Italian work of the same description.

Several houses exhibited imitations of Japanese furniture in bamboo, as well as lacquer and inlaid hard woods; but while almost as costly as the originals, they lacked their inimitable quaintness of construction and exquisite finish.

The cheap furniture shown was confined to a few exhibits of unpainted pine not specially noteworthy, and the well-known bent-wood work, of which almost every country had some examples.

Of moderate priced furniture enough was exhibited to indicate a lighter and more graceful form, and better upholstering work, than the corresponding class of articles in the United States possess.

Judging from the small amount and ordinary quality of the brass and iron furniture, it would seem that the popularity of that style for household use is rather on the decline.

There was the usual display of tables transformable into writing desks, music stands, etc., and upholstered benches that might become lounges or chairs or beds. Such articles generally have the faculty of filling a great number of functions and of not being thoroughly satisfactory in any one.

Many of the billiard tables were supplied with leaves to place across the cushions, by which they could be made to serve as dining-tables; they lack the points along the "rail" for guiding the eye of the player, and in general their fitness for the game is rather lost sight of in the desire to make them light and decorative.

FRENCH COLONIES.

From the many French colonies and protectorates there was a varied exhibition which it would be useless to attempt to describe without illustrations.

The Asiatic and Indian forms retain their strong and somewhat awkward but characteristic lines, and are apparently little influenced by the encroachments of European civilization. Considered in detail there was much to admire of delicate carving, incrustated and inlaid work.

Tunisia exhibited several cabinets and boxes rather roughly carpentered, but covered with a very durable and hard lacquer of a rich brown-red color.

ITALY.

The furniture in this section drew great notice, and the principal exhibitors were freely patronized by the public, who were doubtless attracted by the fanciful carving and comparatively moderate prices. The style was principally Renaissance, and the woods most used were walnut and pear. The carving generally had not the delicate finish of that in the French section, but was far more vigorous and spirited.

"Besaul-Pancier" had some admirably carved mirror frames, and a mantel representing cupids at play in a garden. The figures were excellent, and the execution of the vines and shrubs showed a very skillful hand.

Gajani, of Florence, exhibited bas-reliefs cut from single blocks, and representing in a most spirited manner troops of crusaders and various scenes from mediæval life.

Garino exhibited a buffet handsomely carved; two knights in armor with drawn swords, supported the body of this piece, and its lines were more pleasing to the eye architecturally than was the case with most of the similar articles in the Exposition.

Sarfatti also had a good exhibit of walnut and pear sideboards and cabinets, abounding in most vivid and lifelike dragons, vampires, etc.

Guetta, of Venice, displayed a buffet, every square inch of which was covered with carving; its price was 1,800 francs.

Testolini's reproduction of the chimney of the Doge's palace, and his chairs found great favor with the public. These chairs have square seats, but the low, semicircular carved strip serving as a back has its center at the corner formed by two of the sides, instead of in the middle of one side. There was very little upholstered work in this section.

BELGIUM.

The Belgian exhibit was not sufficiently large to admit of drawing any general conclusions beyond that, as in France, the tendency of

this industry is imitative of the past centuries, and that a cheaper rate of remuneration for skilled labor enables the Belgians to produce at a smaller cost than the French.

Manteau's Renaissance furniture, in oak with gilded carvings, showed both skill and good taste.

Briot's embroidered curtains and hangings were rich and effective, while his dining-room set of Flemish pattern was heavy and rather graceless.

Neuville exhibited a finely-carved Louis XV billiard table, price 5,000 francs, and a somewhat simpler Louis XVI ebonized wood table, three of which were ordered for export to America at a price of 1,300 francs each.

Among Toulet's billiard tables of various styles, the one finding most favor was in oak with brass Renaissance ornamentation.

Denis, Errard, and Devilliers all had handsome exhibits of chimney pieces, columns, and pedestals made of marble from the Belgian quarries. The sculpturing was mainly in low relief, and very fine. The pieces in pure black marble, known as *noir fin* and mottled red, (*rouge griotte*) were not surpassed by anything of this description in the Exposition.

Large specimens of natural wood flooring were shown by De Waele, of Molenbeck, and Dammam & Washer, of Brussels. The woods used were chiefly oak, ash, walnut, and ebony, the joining and inlaying being of the nicest description.

Dammam & Washer exhibited sections of flooring styled "hydrofuge," for use on the ground floor of hospitals, schools, or public buildings, when it is desirable to avoid dampness. A bed of brick or concrete, slightly arched, is laid between the iron sills and sleepers. On this, concrete plates a foot square by 2 inches thick are placed; these plates are either grooved with shallow gutters, or perforated at intervals with slanting holes. A layer of asphalt is then spread, which fills the interstices, and in which the pieces of wood are imbedded. The above is naturally not the cheapest method for laying wood flooring, but its solidity and sanitary qualities have caused its adoption in many of the most important public buildings of Brussels.

AUSTRIA-HUNGARY.

The exhibit in this section was confined to some bent-wood work, a few very ordinary bedroom sets, and some Croatian hangings and curtains gaily striped and colored.

DENMARK.

Apart from some chairs and a bookcase desk of old Danish form, the only noticeable exhibit from this country was a handsome door of oak inlaid with mahogany in a few very graceful and simple scrolls. It formed part of a reception room, made by Oxelberg for the use of the king, on the occasion of a recent exposition.

GREAT BRITAIN.

As was the case in all the foreign sections, the English exhibit under Classes 17 and 18 was extremely slim. The manufacturers, however, claim to have, equally with the French, technical perfection in the various branches of the furniture trade, while modifying their forms to suit the somewhat simpler and severer English taste.

Edwards & Roberts exhibited specimens of Sheraton and Chippendale, and F. Giles had very handsome satinwood furniture of light and graceful form, beautifully but simply inlaid; also a dining-room set of pollard oak carved in Louis XIV style.

SWITZERLAND.

The few isolated examples of furniture in this gallery demand no special mention. The industrial schools of Meiringen and Brienz had, however, some examples of wood carving on panels very prettily executed.

The Brienz school is free to graduates of the public schools, and the course is of three years' duration. The first year is devoted to drawing and modeling. During the remaining two the scholar executes, and the proceeds of his handiwork are divided between the institution and himself.

JAPAN.

The Japanese exhibit contained many beautiful silks and woven fabrics for curtains and other household or decorative purposes. The designs and combinations of colors, though strikingly original, were always harmonious.

There were numberless "étagères," small tables, cabinets, etc., of natural polished woods, or of lacquer with bronzed and gilt Japanese figures and landscapes in relief. However simple the article, its construction showed the ingenious quaintness and marvelous delicacy of workmanship in which these people excel.

In the center of the hall was a small room matted and curtained after the Japanese fashion, but containing among other things a few light chairs of European form. The material was teak wood, unvarnished and without carving. The forms were extremely graceful, the upholstering excellent, and the general effect suggested greater cleverness in copying our methods than we show in imitating theirs.

CHINA.

The Chinese pavilion scarcely exceeded the dignity of a cheap bazaar. The few carved objects it contained were of familiar style and not worthy of special note.

RUSSIA.

The most attractive example of bent-wood work, a screen with graceful compound curves, was in this section. An exhibit of malachite tables and two chests of Scandinavian sixteenth-century style, with some very glaring and ugly Byzantine marquetterie, completed the list.

UNITED STATES.

The Brunswick Balke Collender Company exhibited billiard tables, which met with success. Cutler & Son and Derby Kilmer Company exhibited desks of the type familiar to American offices, and Merklen exhibited spiral furniture. The above, together with a few exhibits of cheap furniture, reclining chairs, and wire mattresses, constituted a display which represented very inadequately the present condition of our furniture industry.

CLASS 20.—CERAMICS.

There were in this class 616 exhibitors, of whom 335 were French, 65 from the French colonies and protectorates, and 216 from various foreign countries. The exhibits comprised a great variety of articles belonging to different branches of the ceramic industry and art, including art porcelains and faiences, industrial porcelain, enamels, mosaics, enameled lava, and ceramics for construction purposes, among which were decorative and building tiles, bricks, terracotta, etc.

The principal European producing countries are France, Germany, Belgium, Denmark, Holland, Austria, Italy, England, and, beyond the seas, China, and Japan. The following table shows the customs duties of various countries on porcelain and faiences :

Country.	White faience.	Decorated faience.	White porcelain.	Decorated porcelain.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Germany	12.50	20.00	17.50	37.50
England	Exempt.	Exempt.	Exempt.	Exempt.
Austria	12.50	20.00	17.50	37.50
Belgium	10.00	10.00	10.00	10.00
Brazil	25.30	.....	85.20	.....
Denmark	17.50	46.80	46.80	93.60
Spain	26.58	26.58	37.50	37.50
United States	60.00	.....	55.00	60.00
France	8.00	12.00	10.00	50.00
Greece	Exempt.	Exempt.	14.06	35.16
Italy	12.00	18.00	12.00	32.00
Holland	5.00	5.00	5.00	5.00
Portugal	11.00	56.00	112.00	112.80
Russia	20.75	61.05	107.43	429.74
Servia	6.00	6.00	6.00	6.00
Sweden	14.00	22.00	14.00	65.00
Switzerland	16.00	16.00	16.00	16.00
Turkey	8.00	8.00	8.00	8.06

In ceramic, as in other old arts, the progress realized and the new features introduced are gradual and difficult to define, the changes taking place under the influence of the varying taste and temper of different nations. It seems at present as if more effort and ingenuity were devoted to the rediscovery of some old forms than to the invention and evolution of new ones. Thus the "nouvelle porcelaine" introduced by Sèvres in 1884 is, from the admission of Mr. Lauth, then director of that manufactory, a composition long known to the Chinese. From a purely artistic standpoint the really new feature illustrated by the present Exposition was furnished by the Royal Manufactory of Copenhagen.

NATIONAL MANUFACTORY OF SÈVRES.

The products of Sèvres comprised four hundred and twenty-four pieces of all sizes, and were exhibited under four categories:

First. "Porcelaine dure."

Second. "Porcelaine nouvelle," including (a) biscuits, (b) flambés,

Third. "Grosse porcelaine."

Fourth. "Porcelaine tendre nouvelle."

"Porcelaine dure," of which the composition was definitely established by Brongmait in 1836, under a formula still retained, is a mixture of kaolin and feldspath, the latter giving transparency. The cover of this paste is also prepared with feldspath, and thus the materials are directly furnished by nature.

The most conspicuous examples of the above were a large and beautiful smooth white vase with plain gilt bronze trimmings, and a vase of graceful form, designed by Carrin-Belleuse, representing a triumphal procession.

"NOUVELLE PORCELAINE."

The old "porcelaine tendre," so called because of its comparatively slight resistance to scratching with a hard substance, was an artificial composition, both the biscuit and its varnish cover being prepared in the chemist's laboratory, and was cooked at a relatively low temperature. As the ceramic colors are of the same nature as the cover, and possess the same degree of fusibility, they penetrate the latter, whereas they only become fixed on the surface of the hard feldspathic rock constituting the epidermis of "porcelaine dure."

Mr. Lauth, until recently director of the Sèvres manufactory, undertook the task of devising a porcelain similar to the Chinese, permitting the employment of real transparent enamels and suppressing the colored pastes. His researches were brought to a successful conclusion, and the new product appeared under the name of "Nouvelle porcelaine" at the Exposition of Decorative Arts in 1884, where it was greatly admired. It has since taken a position as one of the

standard fabrications of the manufactory, and may be considered a mean between the hard and soft porcelains, imitating to a certain extent the solidity and durability of the former and the adaptability to rich decoration of the latter.

The following figures, giving the composition of different porcelains, are from the work of Mr. Lauth on Ceramics, published in 1888 :

<i>"Pâte dure" of Sèvres (cooked).</i>		<i>Chinese biscuit.</i>	
	Parts.		Parts.
Silica	58.0	Silica	70.0
Alumina	34.5	Alumina	25.0
Lime	4.5	Potash and soda....	5.0
Potash	3.0		
Total..	100.0	Total.....	100.0

Thus the Chinese porcelain differs from the hard in that it contains a much larger proportion of silica, a much smaller proportion of alumina, and no trace of lime.

"Nouvelle pâte" is composed of—

	Parts.
Silica.....	64.03 or 71.00
Alumina.....	28.92 or 23.00
Soda and potash.....	7.05 or 6.00
	100.00 100.00

according to the nature of the pieces to be fabricated.

The composition of the covers is as follows (cooked):

	"Porcelaine dure" de Sèvres.	Porcelaine de Chine.	Porcelaine nouvelle.
Silica	70.64	68.00	66.56
Alumina and iron.....	17.60	12.00	14.23
Lime	1.31	14.00	15.51
Potash and soda.....	9.39	6.00	3.59
Water and volatile substances.....	.34		
	99.28	100.00	99.89

The cooking point of the nouvelle porcelaine is about 135°, while that of porcelaine dure is slightly over 150°. These figures, confirmed by practical experiments, show the new porcelain to be harder than porcelaine tendre (in fact steel makes no impression on it), and at the same time more plastic than "porcelaine dure," and easier to mold and manipulate. The cover is of great transparency, white and well glazed, and adheres in a thicker layer than that of hard porcelain. This gives it the softness of the "pâtes tendres," and multiplies under the colored enamels the plays and reflections of the light.

Finally, the cooking being effected at a lower temperature, the fabrication is easier and cheaper, and it becomes possible to employ in the decoration certain colors that would be destroyed and would disappear in the fiercer fire necessary for cooking the hard porcelain. Among these is the red, known as "flambé," so much admired on Chinese porcelain. At the temperature of 135° aluminate and silicate of cobalt give blue of sufficient fixity; and, finally, without the addition of coloring oxides, it is possible, by introducing in the paste infinitesimal quantities of clay containing iron, to impart an amber tint.

Of the four hundred and twenty-four pieces exhibited by the Sèvres manufactory, three hundred and fifty were in "nouvelle porcelaine," illustrating a great and beautiful variety of colors both delicate and vivid. A vase, about 1 metre in height, presented by the French Government to the retiring United States minister, Hon. Robert McLane, represented the effect of moonlight on the waves of the ocean.

The largest piece exhibited by Sèvres was a group of peacocks in biscuit of nouvelle porcelaine. The height of the piece was 3 metres. Very successful specimens of vases with "flambé" ground were also shown.

GROSSE PORCELAIN.

There is another new feature of Sèvres introduced by the present director, Mr. Deck.

The paste has greater plasticity than any of the others, and can be rapidly handled and directly engraved on by artists not necessarily expert ceramists.

This style of porcelain is thought to be restricted in its application to large pieces of a special class, such as garden and flower vases, and is not yet considered, in the present condition of its development, as entitled to rank with the other beautiful productions of this famous establishment.

The Sèvres manufactory has also resumed the fabrication of porcelaine tendre, though its composition has been slightly changed. Among the vases and sets shown the most noticeable were those of turquoise blue and yellow.

In the French section the exhibit of Deck was chiefly remarkable for the greenish-blue celadons and the golds and for superb large decorative plates painted by Collin, in which the gold ground under the glaze and "cloisonné" enamels marked the display with a distinctive character.

Gallé, of Nancy, who exhibited in the furniture, the glass, and the ceramic classes, was awarded a grand prize and two gold medals. In all these departments his exhibits showed, in addition to artistic and skillful workmanship, an originality of composition and a progressive effort to invent new forms and methods that deserved the recognition received.

The art of industrial "faïencerie" exhibited by Gallé displayed enamels of great variety of color. Some of the pieces were decorated with natural flowers, some with paleontological specimens.

Clement-Massin exhibited exact reproductions of Persian and Moorish forms. His pieces in peacock blue and deep red were particularly good, and his faïence with metallic reflections,* that give endless and weird decorative effects according to the angle at which they are held toward the light, obtained for him a gold medal.

Montagnon has resumed at Nevers the fabrication of faïence for which that place was formerly celebrated, and claims to have rediscovered the fixed blue and white colors, the secret of which was for a time lost. His forms are mainly imitations of old French pieces—such as those to be seen in the Cluny and Louvres museums. The exhibit of Montagnon contained, among other remarkable articles, a plate with yellow ground 1 metre 30 centimetres in diameter, the largest yet made, representing an incident in the life of Christ.

GREAT BRITAIN.

England was well represented in this industry by Brown, Westhead, Moore & Co., Copeland, and Doulton. Their exhibits were of the finest quality in the respective lines for which these houses are famous, but presented no remarkably new principles or methods.

Brownfield & Sons exhibited a piece of porcelain in soft paste 3

* The following details concerning metallic lusters are given through the courtesy of Mr. Vogt, director of the Sèvres laboratory:

"For a long time the art of producing these beautiful red, yellow, and violet reflections was ignored in France; they may be developed either on alkaline covers, as the Persians did, or on enamels of lead base, as did the Spaniards and Italians. The lusters shown this year are generally on lead-bearing glaze. Whatever the nature of the cover employed, the materials producing the metallic lusters are always copper for the red and silver for the yellow effects; and the essential point is, that the metal or the metallic oxides used should be in the greatest possible condition of tenuity; this is best effected by roasting with the ocher employed as a vehicle, *oxalate* of copper; the resulting oxide of copper is of extreme fineness. The mixture of ocher and more or less argentiferous copper is painted on the desired parts of the piece to a thickness of about one-half a millimetre; the piece is then placed in an ordinary furnace, and the temperature raised as high as possible without causing a softening of the cover and adherence of the ochereous mixture; this point is about the sombre red period; when this temperature is attained the draft from the top of the oven is closed, and an injection of lighted gas is effected from an opening in the bottom; this gas is extinguished when the oxygen inside the oven becomes exhausted; the heating and introduction of gas are both discontinued, and the oven is allowed to cool gradually. On being removed from the oven the pieces seem at first sight not to have undergone any material change; but the earthy covering of ocher being washed off with water, the metallic lusters appear in all their brilliancy.

"All the covers are not equally apt for receiving these lusters, and I have observed that those giving the best results are where the proportion of silica is at least double that of the bases."

metres 30 centimetres in height and 2 metres in diameter, representing the Earth receiving from Nature the gifts of abundance in grains, fruits, and flowers. In the exhibit of Doultou were most artistic examples of "pâte sur pâte," earthen and stone ware of different tones, also non-enameled and incrustated pastes. Their successful production is difficult, owing to the high temperature necessary for their fabrication.

Doultou received a grand prize for the general excellence of his exhibit, which included almost every branch of ceramic industry and art.

DENMARK.

The Fabrique Royale de Porcelaine of Copenhagen made a display that achieved great success, both from a popular and artistic standpoint, and is considered to have given a new impulse to ceramic art, destined to exert a decided influence on the industry generally. The porcelains were cooked at high temperature (au grand feu) without colored enamels. None of the pieces were very large, but their forms were graceful and refined. The decoration was simple and realistic, consisting of birds, insects, fishes, flowers, natural landscapes, winter and marine scenes. In all of these the only colors employed were white and blue. This exhibit well merited the grand prize awarded it.

BELGIUM.

The factory of Boch Frères at Louvière had a large and fine display of fancy faience, both white and decorated, majolica, and imitations of old Delft and Rouen ware. There were in this exhibit pieces of difficult execution—such as bird cages, musical instruments, large Rouen plates, etc.; but this country seems to be journeying in the reproductive rut, and furnished nothing new of note.

Holland also exhibited imitations of old Delft.

The principal exhibits in the Austro-Hungarian section were the handsome majolicas of Fischer and the porcelain imitations of ivory shown by Stellmacher.

ITALY.

In the Italian department Cartargalli exhibited majolica of artistic merit. There were also several exhibits of terra-cotta figures and subjects executed with spirit but in a somewhat humoristic and trite vein.

The pavilion of the principality of Monaco contained vases, flower jars, etc., of crude but original composition.

CHINA.

As is well known, China was the cradle of the ceramic industry and the fabrication of the porcelain there dates back to many hundreds of years before Christ, the imperial manufactory of Tchang-Nan having been founded in the year 625. The past is, however, more brilliant than the present record of Chinese ceramic art. The present Exposition contained but three exhibits, and they were Chinese in name only, the articles having been manufactured in France and merely decorated by Chinese artists.

JAPAN.

The Japanese derived from the Chinese their first knowledge in the manufacture of porcelain, but their characteristic patience and intelligence have enabled them to far surpass their instructors, and the exhibits, especially of Koransha, Miyakawa, and Hioch-i-yen, showed the highest perfection in the quality and variety of enamels, and the gold and metallic effects employed.

UNITED STATES.

That Japan has exercised considerable influence over the artistic tone of America is generally recognized. This could be seen in the exhibit of the Rookwood pottery, a display that was justly admired on account of the original and unique color of the articles, which presented very warm and rich shades of reddish and yellowish brown, and a natural and simple decoration of insects, flowers, shells, etc., painted under the glaze. The Rookwood pottery received a gold medal.

INDUSTRIAL PORCELAIN.

France, Germany, England, Austria, and Italy are all large producers of table and household porcelain. Of late years the competition of the cheaper German and Austrian articles, and the establishment of factories in North and South America turning out very good products, have somewhat diminished the fabrication of industrial porcelain in France generally.

The chief centers of production are the departments of Limonsin and Berry. The manufactures of Berry enjoy the advantage of being nearer Paris than those of Limonsin, and have also at their convenient disposal the sands of the "Cher Valley," which, mixed with clays of Cornonaille, give good results. Their coal comes by a special canal from Montceau-les-Mines, and its excellent quality enables them to dispense almost entirely with wood fuel.

The most important factory in the department of Berry is that of Hache, Jullien & Cie., which now operates eight furnaces, and man-

manufactures table porcelain mechanically with the "Faure" machines, that produce both oval and round plates and dishes.

Great progress has been made in the last few years as well in the preparation of the porcelain pastes as in the molding and shaping of the pieces. For the fabrication of the paste, the grinding mills formerly used are generally replaced by the "Alsing" crusher, a species of closed cylinder, in the interior of which the materials to be ground and large seashore pebbles are churned together. To complete the pulverization, the materials are passed through small mills having an irregular rotary motion produced by elliptic gearings; this gives the molecules a spheroidal form, preferable to the ellipsoidal obtained by the old continuous movement mills. The paste is next conveyed into a mixer, and thence passes into a double rotating sieve, and finally into filter presses.

The tramping and kneading of the paste, to render it homogeneous and expel the air, formerly laboriously done by foot and hand, are now effected by an ingenious system of mechanical rollers; the fashioning of the plate, whether round or oval, and the removal of the excess of paste, are all accomplished mechanically, and at a much smaller cost than formerly.

In the department of Limonsin this industry is said to have suffered through the interruption caused by the war of 1870, and the establishment of numerous and important factories in Germany and Austria. Since 1878 these are reported as having made great progress, and now produce articles similar to those made in Limonsin at about one-half their price, by reason of better and, at the same time, cheaper fuel, cheaper labor, and cheaper transportation.

These remarks apply, however, more particularly to the common classes of articles in white porcelain; for in the manufacture of decorated ware the French establishments are unquestionably superior.

Haviland & Cie, at Limoges, operate the largest porcelain factory in France, employing about twelve hundred workmen and artists. They obtained a grand prize for the fine quality of their tableware, of which a great variety was exhibited, showing especially pink and yellow colors of great delicacy.

Haviland, Redon, and the other large manufacturers of Limonsin fabricate entirely their oval and round plates with the Faure machines previously referred to.

The manufacture of porcelain flowers is of relatively recent date and is as yet essentially French. The exhibits of Dartout and of Bonsard showed marvelous reproductions of flowers of all kinds, especially roses, that might readily be mistaken for the living articles. Women are employed in fashioning the paste, which is done by hand with the aid of a spatula. The products are cooked with a wood fire, and are extensively used for decorating tombs.

ENAMELS.

Under this name are included the compositions, chiefly with metallic bases, serving to color and decorate various ceramic products. The metallic oxides mixed with dissolvants, such as the alkaline silicates and borates, are ground after their fusion in crucibles, and the fine powder thus obtained is combined with some mucilaginous gummy substance, and diluted with water. The preparation is then spread with a brush either on the raw clay or on that which has already undergone a first cooking, preliminary to a second or enamel baking. To obtain more delicate results, a first coating of thin white enamel is generally spread ; when dry this is followed by the application of the colored enamels. The same method is also employed for enameling on metals.

MOSAICS.

The fabrication of mosaics, until recently almost exclusively an Italian art, is now quite extensively practiced in France, having been introduced by an Italian, Mr. Facchina, established for some years in Paris. Facchina and Guilbert-Martin concurrently executed the mosaics in the Grand Opera. The exhibit of the former contained admirable copies of Venetian frescoes, and that of the latter a reproduction of an aquarelle of Cleopatra by Gustav Doré, the coat of arms of the Ville de St. Denis with two allegorical figures, a head of Christ, and a monumental fountain in the central gallery.

The above mosaics were in enameled glass and showed a palette of great variety of colors.

Two methods are employed for transferring the cubes of glass to the wall, known as the Roman and the Venetian processes. In the former the mural space is hollowed to the necessary depth, and the cubes are directly imbedded in a layer of cement according to the model previously sketched on the plaster wall itself. In the Venetian system the design, instead of being outlined on the wall surface, is drawn on paper which is covered with mucilage. On this the enameled cubes are placed, and when completed the mosaic is transferred bodily or in sections to the wall and implanted in the bed of cement prepared. The paper is then washed off and the interstices remaining between the cubes filled with a solution of lime. This method is quicker and cheaper than the Roman, but is not considered as good when complicated designs are used. The marble mosaics chiefly employed for floors are laid in the same way.

Among the French mosaic manufacturers was Bapterosse, whose specialty is the fabrication of porcelain buttons, beads, etc. The composition of the paste used by this exhibitor is principally feldspathic.

The "École Française de Mosaïque" exhibited a large door in mo-

saic, and the Italian section contained Byzantine mosaics by Salviati and Florentine hard stone mosaics. The façades of the Italian and the Servian sections and the several detached pavilions were decorated with mosaics showing various degrees of skill and taste.

BUILDING AND CONSTRUCTIVE CERAMICS.

If the general exhibit of artistic porcelain and faience showed a constant resurrection of old forms, and, considering its magnitude, comparatively few new methods and ideas, there was, on the other hand, and especially in the French Department, a marked activity and progress in constructive and building ceramics, and a broader application of these materials to architectural purposes than has heretofore been acknowledged or practiced.

The principal domes of the Camp-de-Mars buildings were covered with blue, white, and yellow enameled tiles. The friezes, of 2 metres in height, surrounding the Liberal and Fine Arts galleries, were of terra-cotta and plaster, representing nude figures supporting the shields and escutcheons of all nations. In fact, ceramic products were employed universally and with most happy effects in clothing and decorating the iron skeletons of the Exposition buildings and pavilions.

Though even the newer countries manufacture greater or less quantities of constructive ceramics, France, Germany, Austria, Belgium, and England are the principal producers and export largely. Of the above England was represented at the Exhibition by the well-known work of Doulton. In the Belgian section two exhibitors, Escoyez and "la Société Anonyme, etc., de Seilles-lez-Andenne" displayed enameled and common bricks, tiles of various forms and compositions, and refractory products.

In the French section, among new features was the "reconstituted lava" exhibited by Mr. Gillet.

The employment of lava as a constructive material, its application to certain artistic and industrial purposes, and its enameling, are not new. It was only in 1883, however, that Gillet introduced what is now known as "reconstructed lava." By crushing and pulverizing the natural lava and mixing it with certain cements a material is produced that may be fashioned like the porcelain pastes, and given a wide variety of forms. The reconstituted material is enameled by the same process as the natural lava, and has, aside from greater facility of fabrication, the advantage of being infinitely harder than faience. The exhibit of Gillet contained reproductions of old Persian, Chinese, and Moorish ceramic panels, also tables for laboratories, basins for accumulators, slabs for sinks, etc., water gauges, troughs, etc.

Muller, whose factory at Ivry-sur-Seine covers 3 hectares, with an annual production proportionately large, exhibited great varieties

of plain and enameled tiles and bricks, among which were the double-jointed tiles now in general favor. Muller constructed the tiled domes and the decorative friezes of the Exposition buildings previously referred to.

Loebnitz, who also did a large portion of the interior ceramic decoration of the central gallery, etc., exhibited artistic panels and very rich colored porcelain stoves and fireplaces.

Parvillé Frères exhibited bricks and tiles of a new and cheap enameled porcelain whose composition was not disclosed. These manufacturers assert that the surface enameling, instead of rendering bricks less destructible and making them weather proof, has an injurious effect; that as the unalterability of the material is in direct proportion to its impermeability, and as the ordinary earthen bricks and tilings absorb about 25 per cent. of their volume of moisture, a sudden fall in temperature must always hasten their disintegration and ultimate certain destruction. Hence the advisability of employing a material such as porcelain, presenting conditions of comparatively absolute durability. The porcelain articles manufactured by this firm for building purposes only exceed by about one-quarter the cost of the more perishable earthenware bricks and tiles.

"L'Union Céramique et Chaufournière de France" combined in a special pavilion the collective exhibits of about sixty manufacturers of building tiles and bricks, drainage pipes, etc. Here was also exhibited a model of the new "Simon" oven for the baking of ceramic products. It is rectangular in form instead of circular, and the special dispositions contrived for preliminary heating and the prevention of moisture from condensing on the pieces furthest removed from the fire are said to give excellent results. The heating chambers are by a recent improvement made extensible without necessitating a stoppage of the fire.

CLASS 21.—TAPESTRY, CARPETS, ETC.

This class contained 428 exhibitors, of whom 55 were French; 97 from the French colonies and protectorates; 7 from Belgium; 56 from Roumania; 96 from Servia; 60 from Greece; 14 from England; 8 from Japan; 3 from Austria, and 32 from various foreign countries, the United States not being represented.

Included among the first named were the national tapestry manufactories of the Gobelin and of Beauvais, which are under the direction of the minister of fine arts. No work is undertaken in these establishments without his authorization; but such products as are not reserved for the museums and for the decoration of national edifices may be sold to the public. Connected with the Gobelins and Beauvais are schools to which the admission is by competitive examination, the successful candidates being received as apprentices. For

a long time these establishments produced tapestries of the same kinds; now, however, each has its specialty; that of Beauvais, which is known as "basse lisse," consists mainly of tapestries for chairs, lounges, screens, panels over doors, etc. They are fabricated in a horizontal frame with the reverse side uppermost. The frames, formerly of wood, are now made of metal, and are mounted on a pivoting axis that permits the workman to tilt the piece and conveniently examine the progress and effect of his work. Under the tissue or "chaîne," a sketch of the model is placed, which enables the exact reproduction of the outlines. The light colors are woven in silk threads, the employment of wool being limited to the darker shades. The coloring effects are obtained by the union of two shades; these being again mixed and spliced as it were with other combinations, give a palette of colors no less varied than that of the painter. The thirty-nine tapestries exhibited by Beauvais represented principally floral designs and woodland scenes. The Gobelins exhibit contained forty-seven pieces of the variety known as tapestry "de haute lisse," the largest representing "The Fairies' Godchild," after a painting of Mazerolles. Other panels, destined for the Elysée Palace, represented the Muses; also "La poème héroïque," "Le poème Satyrique," etc. Among the panels intended for the National Library, were "Letters, Sciences, and Art in ancient days," Autumn, Winter, etc. No description of the above tapestries could adequately convey their beauty of texture, or their warmth and delicacy of coloring. The wools for the "chaîne" employed in the fabrication of these pieces are generally doubled and retwisted; the number of threads varies according to the complication of the subject represented, from 800 to 1,200 for a width of 1 metre. They are singed to remove the down. The "haute lisse" products, so called on account of the peculiar disposition of the threads of the "chain" and those of the tissue which are fixed on the upper side of the "chain," are the most perfect, but also the most laborious and costly tapestries. A square metre of Gobelin is estimated to cost 3,000 francs, and represents the entire year's work of an individual.

Braquenié & Co., operating factories at Malines in Belgium, and at Aubusson in France, exhibited in both the French and Belgian sections artistic tapestries rivaling those of the Gobelins, among which is one, after a painting by Rubens, called the "Exchange of two Queens." Copies of paintings by Boucher, Ehrmann, and Fragonnard were among the other pieces. The coloring of Braqueniés tapestries was somewhat softer and less vivid than that of the Gobelin's referred to.

Hamot, of Aubusson, had a very large exhibit of artistic tapestries and woven stuffs for furniture; among the former the "Bath of Cupid and Psyche," after Romain, and the "Cascade," after Mazerolles. His imitations of Persian rugs were perfect; also the velvety

textures known as "Savonnerie," with mixture of wool, silk, and silver threads.

Sallandrouze, of Aubusson, exhibited moquettes and carpets "à point d'Orient," manufactured by a machine recently invented by himself, and which was in operation in the Machinery Hall. The points are visible on both faces of these carpets, and it is thought that when some further modifications shall have been effected in the machine, with the result of tying the points more solidly than at present, it will constitute an important improvement in this industry.

Holland was represented by the "Manufacture royale de Deventer," the most important factory in that country. Most of its products are consumed at home, but have nevertheless an excellent reputation in England and also in France. The large rugs exhibited were of very regular and fine texture, but rather dark and dull in color.

Ginskey exhibited in the Austrian section large rugs of thick velvety texture, and principally in solid colors, with the exception of the borders. Among them were beautiful shades of red, salmon, blue, and yellow.

The English section contained an exhibit of Brussels carpets from the factory of Crossley & Sons, and also a great variety of oil-cloths and linoleums of very excellent fabrication and tasteful designs, among which were imitations of mosaics and marbles.

CLASS 22.—DECORATED PAPERS.

The number of exhibitors in this class was smaller than in any other of Group III, there being but forty-three, all told, of whom twenty-four were French and three Americans.

Although in the last few years there has been a growing tendency to use silks, satins, damasks, tapestries, chintzes, leather, or wood-work for mural decoration, the expense of such restricts their employment to the more luxurious class of houses.

On the other hand, the improvements made in the fabrication of papers have placed the latter mode of decoration within the reach of the most humble, and it would be erroneous to conclude from the meager display of all wall-papers, even in the French section, that this industry is languishing under popular disfavor or is stationary from a mechanical or manufacturing standpoint.

The vast amount of wall space required, which it is of course not possible to have in an Exposition such as the present, and the consequent necessity of showing small samples in folders or books, valueless as an advertisement, doubtless deter many manufacturers from exhibiting at all.

About one-third of the wall-papers manufactured in France are sold to foreign countries, and though the volume of the export trade has not materially changed during the last few years, its money

value has almost doubled, owing to the fact that only the more luxurious and artistic qualities are purchased, as almost every country now produces all the ordinary papers it requires.

The increase and improvement in mechanical appliances has been no less marked in this than in all other industries, and the present Exposition contained designs of 2 metres in height, printed by machine, also employing a greater number of colors than heretofore.

Much originality has been shown in imitating tapestries, mosaics, tiling, etc.

The following observations made by Mr. Shope, the American juror in Class 22, give all the detailed information obtainable on this exhibit, and are submitted verbatim:

In our own section there is only one exhibit of wall-papers, and that hardly shows to great advantage. It has not had the fortune to be well placed or well set off, and such examples as are on view are not, we think, equal to many that may be found in the warehouse of the same manufacturer in New York.

It is Great Britain which has displayed perhaps the most interesting series, both in regard to design, workmanship, color, and ingenuity of methods. In all respects there seems to have been great progress made in late years, and there is no lack of fine examples of all sorts and at all prices. One reason for this excellence may be that architects and artists of the first rank have been employed to furnish the designs employed by many of the firms in question.

Of the other countries exhibiting, it is not necessary to speak here, excepting to say that the work of Japan is what it has always been found in every other department of art, extremely original, artistic, and decorative. If the small specimens here shown are a fair example of the manufacture of the country, it is a pity we have not had opportunity to see them to more advantage.

The exhibit of France consists almost entirely of papers of the more expensive varieties. These are for the most part imitations of different textile fabrics in various degrees of success. We find many imitations of tapestry. The effect is obtained very simply, by covering the design with a grill of fine black lines. The result is to make the paper look more like a woven stuff than the real tapestries found in an adjoining department. Unfortunately, many of the designs employed are not of great merit, and the papers are, as a rule, much darker than those we are accustomed to use. The most interesting exhibit is an imitation of a piece of Flemish tapestry of the sixteenth century, manufactured by machine, and shown by the house of Isidore Leroy et ses fils. The design, color, and the effect of a tapestry are admirably done. Moreover, the motif can be separated into seven panels, each of which can be used separately if desired. We notice from the same firm a rose-covered paper with a design of cherubs and garlands of charming color and movement.

Messrs. Hooek frères exhibit some imitations of stamped leather, and a design for a dado very ingeniously devised to follow the steps of a staircase.

Mr. Romain shows imitations of satin and velvet hangings. The effect is remarkably deceptive, but the designs are unfortunately inferior both in color and form. In the same exhibit may be seen a very interesting adaptation of Japanese designs.

Mr. Petitjean is perhaps as far advanced in the manufacture of papers by machinery as any of the exhibitors. His factory produces work of twenty-four colors, and 2 metres in height. One example of this is a so-called tile paper, with a Japanese motif of storks. Besides, we find an imitation of tapestry very skillfully done. The subject is a scene from peasant life. This exhibitor shows also some hand-painted papers which are a novelty. The decorative effect would be excellent

if properly set off. We are given in one a hunting scene, and in another a man at arms, both life size.

Mr. Pacon, Mr. Cadot Jeune, and Mr. Tollott all exhibit remarkable imitations of silk, satin, and velvet. The resemblance is so strong that it might almost defy detection.

Mr. Jouanny exposes an imitation of velvet with a long nap, very effective in decoration, and one of satin in a Louis XVI design, very delicate and graceful.

Messrs. Gillou et fils exhibit some papers called hygienic, which can be washed without injury.

In the department of the United States, Warren, Lange & Co. are the only exhibitors of paper hangings, and the specimens here shown compare very well with any other exhibit of the same grade.

The most interesting exhibit is that of England. We are shown any number of examples of the most charming and artistic designs at all prices, and suited to every variety of employment. While the cheapest seem to fall below our own manufacture in price, the finest are not much more expensive than the corresponding grades with us. We notice a great variety of new methods of manufacture, principally in the production of the more costly varieties.

The Anoglypta Company make a most interesting exhibit. Their work is entirely in relief. By subjecting the paper to pressure in molds while still in the condition of pulp, they produce a much higher and primer relief than other processes, and one which should prove more lasting. They claim besides that they are thus able to produce their manufacture at less expense, as they save one process in making. We have not here to deal with an imitation of stamped leather, but something more like plaster and carton-pierre. The result obtained is so fine and clear, and is capable of such artistic treatment, that it will surely have a future. For the most part the work is decorated after being hung, which is in some ways an advantage. We are shown one example in which the color has been wiped off the parts in relief after being painted. The result is very effective. In others the raised parts are painted different colors.

In the exhibit of Messrs. Jeffry & Co. we see flock papers, embossed papers, and ordinary machine-made papers, but no new methods. However, the merit of what is shown is great, especially the designs of Mr. Walter Crane. In some ways perhaps it is the most striking exhibit to be seen. We have noticed particularly a design called the "Golden Age," in an embossed paper, which is most charming and graceful. The Trocadero design, used in the fine art galleries of the British section, is also remarkably successful.

The Fishers Patent Wall Hanging Syndicate have introduced a somewhat new idea in the employment of canvass to back up their hangings. This enables them to use oil colors entirely instead of water, and to produce a material which can be washed with impunity. For schools, hospitals, etc., the advantages are manifest, and in private houses it would be found useful. It has, besides, the merit of being damp proof, and will not discolor or run on walls which are exposed to wet. The effect in general is good, and where rooms contain oil paintings this decoration would make a most effective background, and one which is altogether a substitute for painting directly on the walls by the aid of stencils.

Messrs. William Woollams & Co. are another firm who show a new method of making relief papers. The manufacture is not described, but the embossed surface is hardened by a special process so that it will not flatten under the softening action of the glue. We find also some flock papers remarkably artistic in design, which, like the others, are sold in the white to be painted after being hung. This system seems to have grown much in favor, and has unquestionable advantages. More originality is secured, and a room can be given any tone desired. In the exhibit of this firm there are also papers in which mica has been employed to give brilliancy to the design. All of their manufactures are warranted to be free from arsenic.

Wylie & Lockhead show papers which can be washed without injury. It is not quite evident whether this is due to their being printed in oil or not, but we notice the adoption of a system of brown lines in the shading of the designs, like a wood engraving.

In the exhibit of Japan perhaps the most artistic and distinctly decorative papers of the whole Exposition are shown. In addition to the varnished and lacquered papers which are more familiar to us, there are some more simple in design, in one or two colors only. Trailing vines, delicate flowers, birds, and fruit, treated very plainly make inexpensive papers which are not excelled anywhere in point of taste. We are unfortunately not shown very large specimens, but it seems they are only made in small squares, which are pasted together in order to cover large surfaces. They are not shown in such a way as to call public attention to them, and have hardly been noticed as they deserve. Mr. Horiki shows some papers called "Tsuboyagami," which are especially interesting.

CLASS 23.—KNIVES, PENKNIVES, SCISSORS, RAZORS, ETC.

There were but 91 exhibitors in this class, of whom 35 were French, 2 English, 6 Belgian, 3 United States, 2 Russian, 20 scattering, and 23 from the French colonies and protectorates.

This meager showing was not startling, so far as concerned most of the foreign countries, for in almost every class of Group III they made a very inadequate exhibit. It is, however, rather surprising that France herself should only have produced thirty-five exhibitors against fifty-eight at the 1878 Exposition, and that England's cutlery should be represented by two insignificant exhibits.

The principal centers of fabrication are England, France, United States, Russia, and Sweden.

The rather heavy English forms do not please in France, which buys but a small quantity of cutlery from that country. The excellence of the English material and the careful and workmanly way in which the steel is tempered, ground, and sharpened, are, however, universally acknowledged.

The Russian products seem well made and of good form. Kondratoff exhibited fine table cutlery but little inferior to the French in elegance and workmanship, though somewhat cheaper. In the vicinity of Nijni-Novgorod excellent steel is manufactured, and there was a good associated exhibit from that place.

The principal French centers of fabrication are Nogent (sur-Marne) for fine cutlery, especially pocket knives, Chatellerault for table cutlery, Thiers (Puy de Dôme) for cheap articles, and Paris for expensive fancy cutlery.

At Nogent this industry dates back to the fifteenth century, and though important factories exist there the work is largely done by individuals at their homes. Almost the entire population of this district is occupied either in the manufacture of cutlery or in its sale and marketing. As a rule, the son follows the trade of the father, and having the advantage of starting with the gathered results of his experience, a superior and skillful class of workmen consequently

exists there. The annual production is valued at about 6,000,000 francs.

The "Syndicat des Ouvriers Couteliers de la Haute Marne" made a good exhibit, and Didier-Charbonné showed scissors capable of being dismounted, ground, and remounted without requiring a screw-driver.

Thiers produces annually 14,000,000 francs' worth of cheap cutlery, of which about one-third is exported to foreign countries—notably Italy, Turkey, Egypt, and South America. The remaining two-thirds find a market in France. Great progress is said to have been made in the methods of fabrication of this class of articles in the past few years, with the result of lowering the price without deteriorating the quality of the products.

The association of "Ouvriers Couteliers de Thiers" exhibited very presentable knives, manufactured at a selling price of 4 to 6 francs per dozen.

Thinet exhibited a contrivance adaptable to pocket knives for securely holding the blade open or at any desired angle.

The exhibit of fancy table cutlery made by the leading Paris firms, though not large, was very beautiful. In this industry the tendency to revert to old forms, both in the shape of the blade and in the decoration of the handle, is very marked. Mr. Marmun, the reporter of the jury for Class 23, had a retrospective exhibit of cutlery from the year 1550 down to the present day. The fine articles manufactured in Paris are of high price, both on account of the elaborate decoration of the handles and the greater care used in the preparation of the material. To this end the blades of knives or of scissors are obtained by successive stretching and hammering of the metal, instead of by stamping from a steel bar, as in the case of common articles.

Cardeilhac exhibited table cutlery of great elegance and knives with mother-of-pearl or ivory handles beautifully ornamented with silver, a strip of the latter also extending part way along the back of the blade.

The union of the silver with the steel is an exceedingly delicate operation, as the temperature required for tempering the steel is almost sufficient to melt the silver.

There were various exhibits of a nature more curious than useful, such as a so-called "pocket (?) knife" 2 metres in length and weighing 150 pounds.

Another knife of somewhat more modest dimensions contained seventy-five blades and various instruments. It was so constructed as to be divisible longitudinally into three sections, and its price was 1,250 francs.

There were various patented articles, such as hair clippers, razor guards, etc.

American cutlery is similar to the English in form, and its excellence is gaining for it increasing recognition abroad. Our three exhibits suggested but faintly, however, the very prosperous condition of this industry in the United States, and their display contained nothing requiring special mention.

CLASS 24.—GOLDSMITHS AND SILVERSMITHS' WORK.

CHURCH PLATE, DECORATIVE AND TABLE PLATE, ARTICLES OF GOLD AND SILVER FOR THE TOILET, FOR OFFICE USE, ETC.

Most of the foreign sections contained a few exhibits under this class, illustrating the workmanship and forms peculiar to the country.

As in several other classes of Group III, there is again in this a noticeable tendency on the part of the older European and Eastern countries to turn to the past for inspiration in the designs, and as workmanship and individual skill can not be expected to constantly improve there remains but little to note.

So far as could be ascertained no new processes of manufacture have been recently developed, and the more artistic work is done as of old with the hammer and chisel.

In the British section the Goldsmiths and Silversmiths' Company exhibited table and house plate of plain and heavy old English form and some handsome gold and silver pieces filigreed and decorated in East Indian style.

Siam and Japan had a few examples of silver work repoussé and enameled, and the Spanish section showed some very delicate silver and gold inlaying.

The Danish exhibit contained some large frosted silver center pieces, and the Russian section, which is said to have made a very fine and large display in 1878, contained only a few enameled and etched gold and silver articles of Caucasian form, presenting no remarkable features.

In France the center of fabrication for gold and silver work is Paris, except for articles intended for church and religious use, several of the largest manufacturers of such being located near Lyons.

In the Trocadéro was a retrospective exhibit of religious "orfèvrerie" from the time of Louis IX to the present, and the French section proper contained various large pieces of fine workmanship and great beauty, especially an altar in bronze gilt designed in fourteenth century style for the Church of St. Ouen de Rouen. This piece measured about 11 metres in height by $5\frac{1}{2}$ metres in width, and was from an architectural point of view most attractive. Of articles for ornamental and table use the leading French gold and silver smiths had elaborate and beautiful displays, chiefly in fifteenth century style and of admirable execution. The forms were, however, conventional, and there seemed to be but little attempt to devise new

treatment and combinations of the metals. For this the manufacturers hold the public responsible, and maintain that while the preference of the latter is so decidedly for old forms, copies of Louis XIV, Louis XV, etc., they can scarcely be expected to try new and costly experiments in the effort to create a new school of public taste.

The exhibits of Froment-Meurice and Christofle & Cie, two of the most important French houses, consisted mainly of carved and chiseled silver plain polished, there being comparatively little etching or enameling.

The latter firm make use of a new and simple process of obtaining impressions of natural plants and flowers. The plant is first dried and hardened, and on being pressed or struck in some peculiar manner against the metal plate previously covered with gold-foil, imprints an exact outline, which is afterwards worked up in various ways, etched out, or filled with other metals, etc.

The United States made in this class an exhibit which attracted deserved attention and admiration from the public as well as the jury, and showed how much can be accomplished where the restless search for new forms and effects is modified and directed by good taste. The criticism often made against American workmanship, that in the effort to produce quantity, quality and artistic consideration are lost sight of, could certainly not be applied to the exhibit of Tiffany & Co.

The Gorham and Meriden Britannia Companies also made excellent exhibits in their respective lines.

The exhibit of Tiffany & Co. in 1878 was mainly imitative of Japanese forms, but the general style of their silverware at the present Exposition was a modification of Saracenic and Persian, etched with great beauty and infinite variety, even the smallest pieces of the same set having different designs.

A new feature was presented in the artistic blending of colors in the articles of enameled silver, and the peculiar opaque appearance of the enamel itself. A silver vase, 25 inches in height by 22 inches in diameter, was the most elaborate piece of this description. The orchids enameled on its surface each contained from four to five distinct colors blending imperceptibly, while by some employment of acids on the surface of the enamel the soft velvety appearance of the flower is perfectly given.

A laminated vase, believed to be the largest piece of its kind ever made, was composed of fine gold and silver and three Japanese alloys folded together and backed with sterling silver; the necessity that each metal should stretch and flow alike makes the process of hammering and rolling extremely difficult.

The chiseled and repoussé work was of the highest merit, and the Exposition contained nothing under this class showing greater delicacy of workmanship than a large silver tea set exhibited by this

firm, on which the common field flowers of America were designed. Several jugs, coffee-pots, etc., with a peculiar damask finish, were shown; also some smaller articles of gold, stained in such manner as to disclose a faint pattern or design when held obliquely. The latter is a new and difficult process, the secret of which Tiffany & Co. claim to have discovered.

The ivory and ivory-mounted articles for the library or dressing-table were mainly copies of forms in use among the Alaska Indians, though for somewhat different purposes, and were stained to give the effect of age.

*CLASS 25.—ART BRONZES AND CASTINGS, ARTISTIC IRONWORK,
AND REPOUSSÉ METAL WORK.*

There was a large exhibit of forged ironwork in the French department, comprising sections of balustrades, railings, screens, lamps, lamp-stands, and even picture frames and various small decorative articles.

A few foreign sections, notably the Belgian and Italian, also contained some good examples.

After giving due credit to the excellent workmanship shown, especially in the French department, and noting an apparently increasing appreciation on the part of the public for work of this description, there is little to be said. The manufacturer must remain, so far as this industry is concerned, entirely dependent on his own good taste and originality in designing, and his individual skill in executing.

Of repoussé work in copper, lead, and zinc there were very handsome monument fountains, statues, etc., shown by the principal French firms.

Gaget-Gauthier exhibited in the central gallery a magnificent fountain of hammered lead modeled by Bartholdi, representing the Chariot of Progress. This firm executed the Statue of Liberty that stands in New York Harbor, and exhibited interesting reductions and models showing the details of its construction and erection. From calculations and measurements on the original model, plaster casts or models of the different parts and of the actual size required are obtained. Cradles or skeleton molds of wood are then constructed, corresponding exactly to the surface of these plaster casts; and on these frames the metal plates are fashioned into shape, either by pressure or by hammering with broad mallets. When there is a question of more intricate and complicated form, the plate is heated to render it more malleable, and the work is completed with a small hammer. The statue is erected by means of temporary supporting frames and scaffoldings, afterwards replaced by interior ribs and armatures of iron.

Marron, of Rouen, exhibited a fine fountain of wrought iron.

ART BRONZES AND CASTINGS.

The Exposition of 1878 had already revealed the superiority of the Japanese over European bronze-workers, and had made evident the fact that they possessed technical devices or methods of casting, unknown to the latter, by which a more direct and lifelike reproduction in bronze was obtained. These processes, like the other artistic and industrial secrets of that people, were carefully guarded and surrounded with a veil of mystery difficult to penetrate. With one signal exception, the present exhibition showed nothing remarkable as illustrating new principles or processes. Japan on this occasion sent only a fountain of no great merit, and a few bronze vases and small jars.

The Russian section contained an excellent exhibit of small figures and groups, representing Russian and Tartar hunting and love scenes. They had the charm of novelty, and were picturesque and natural in execution.

The French section contained an exhibit of statues, busts, etc., principally reproductions of known works of art both ancient and modern, and reductions of the same; a proceeding which has become very common of late years, and is not altogether a subject for rejoicing from an artistic point of view.

Two methods are present in general use for casting bronzes: (1) by the use of sand; (2) by the use of wax afterwards eliminated (*cire perdue*).

In casting with sand the artist first delivers a plaster model of the statue, on which an impress is taken in sand properly kneaded and worked. This mold is then covered with a solid coat, dried in the furnace, and divided into two halves or shells fitting each other exactly. A statue also in sand is then fashioned in the mold; this is destined to serve as a core, and is reduced over all its surface by an amount equal to the destined thickness of the bronze. The metal is next poured in the hollow thus formed between the mold and the core, after which the exterior mold is broken, and the core of sand removed through openings in the statue left for the purpose. Finally, if made in sections, the different parts are adjusted, the seams and inequalities trimmed and polished, and the desired color given to the bronze.

In casting with the use of wax, a process derived from the Florentine founders, on the original plaster model, a mold also in plaster is made. In this mold the core or temporary statue of sand is formed, and afterward reduced by scraping so as to obtain between the two surfaces the space destined for pouring the metal. But instead of proceeding directly to casting the metal, molten wax is then poured in the hollow, and on removing the outside mold of plaster there remains a statue of wax sustained by the porous

earth core perforated in all directions to permit the escape of the gases. This "trial" statue of wax is then retouched and finished by the artist according to his fancy, and replaced in a new exterior mold accommodating itself exactly to the modifications affected in the wax statue. On being heated in the furnace the wax melts and escapes through openings left for the purpose. The metal is then poured in, and the result is a bronze image reproducing the artist's ideas more directly and delicately than by the sand process.

The following explanation of the Japanese method is substantially given by Mr Philip Daryl, who claims to have received it four years since from a Japanese merchant of Tokio now established in London:

Each casting requires a special model carved in wood, representing as exactly as possible the form of the original, and on which the sculptor carefully models in wax the proposed details and decorations. If these ornaments are of a fragile nature, such as parts of plants, feathers, etc., they are held under the wax by bands of brass wire. The wax having previously been mixed with resin to give it greater hardness, the artist alters and modifies his model until he is fully satisfied with it. This model it is now his object to reproduce in bronze with absolute fidelity.

Instead of proceeding to take a rough sand or plaster mold of this model, as the European does, he next spreads with a brush over the wax a sort of transparent paint formed of a very finely-ground white powder dissolved in water, using great care to avoid leaving any small air-bubbles under his first coat. When dry, he applies a second, a third, and a fourth coat of this transparent paint. In this way he obtains a veritable epidermis, accommodating itself to all the details of the wax model. On this skin successive layers of a coarser solution form a somewhat thicker and tougher covering. Finally, sand worked and kneaded by the hand completes an exterior mold, and a jacket of plaster protects this in turn from accident.

The whole mass formed by the original core and its successive envelopes is then slowly dried in warm air and afterwards placed in the furnace. The wax melts and evaporates through the pores of the exterior mold. When this evaporation is thought to be completely effected, the pouring of the metal takes place while the piece is still warm, a condition essential for the penetration of the bronze into the small corners and sinuosities.

The casting being done with one pouring, it only remains to extract from the statue its core of wood. This is either done mechanically or by reducing the latter to ashes.

It will thus be seen that the Japanese operation is in some respects the reverse of the European "lost-wax" method. As, instead of first making a mold on the original model and pouring in this mold a wax medium more or less imperfect in spite of the retouching it

receives, the Japanese form their model directly on the original model of wax, and in this way succeed in giving almost a living reproduction of the desired object.

Thiebaut frères, a house that has been in existence more than a hundred years, exhibited a duplicate of the large equestrian statue of Etienne Marcel recently placed in front of the Hotel de Ville. The rough casting is exposed as it came from the mold, without trimming or polishing, and is noticeable as a very large and successful example of such casting. They also exhibited a statue of Lafontaine, modeled by the sculptor Dumilatre, destined for one of the public parks, and reductions of Bartholdi's statue of Liberty.

The Société Anonyme des Hauts-Fourneaux et Fonderies du Val d'Osne, which has supplied most of the fountains adorning the public squares of Paris, had also a large display of cast iron and bronze, both plain and colored. The specialty of this company is cast iron bronzed and coppered by the galvanoplastic process, afterwards colored by the use of various acids.

There was an interesting exhibit of reductions of the works of the celebrated French sculptor Fremiet in plain bronze, bronze gilt by the mercury process and silvered by galvanism.

The works of the above houses are mainly cast by the "lost-wax" method.

Ringel d'Illzach exhibited a large bronze vase, 1 metre 20 centimetres in height, 60 or 70 centimetres in diameter, which constituted the one sensational novelty of the bronze department. The vase has no pretension to any special style or artistic beauty; in fact, the exhibitor announces that it is simply a technical specimen illustrating a new method of casting bronze discovered by himself, and the secret of which he very naturally refused to divulge even to the jury. He states that this piece was cast directly on the soft clay with one pouring ("sur la terre molle d'un seul jet"), and the vase bears out his assertion, showing on its surface with a wonderful appearance of reality the imprint of the thumb and modeling tool, also various materials and objects, such as strips of ribbon and embroidery, pieces of velvet and linen, small flies, bugs, etc.

Whether Ringel d'Illzach has in reality discovered a new process, or has mastered some of the secrets of the Japanese procedures, is a matter of discussion; but rough as it is, his work is the one significant feature of the bronze exhibit, and seems to point to newer and better artistic results.

The English, the United States, and other foreign sections contained nothing under this class requiring special notice.

CLASS 26.—CLOCKS AND WATCHES.

The exhibitors in this class numbered 445, almost 150 less than in 1878. Of this number 427 exhibited in the French and Swiss sections, 13 in the English, and 5 in the American.

The products may be divided into—

(1) Time pieces of precision, such as marine and pocket chronometers, watches regulated chronometrically, astronomical pieces, etc.

(2) Ordinary timepieces, comprising watches for general use, mantel and traveling clocks, monumental clocks, etc.

(3) Detached pieces and accessories of clocks and watches.

The principal centers of fabrication for watches are Switzerland, France, America, and England; the former always excelling in the production of complicated watches, and the latter in marine chronometers. Austria and Germany manufacture large quantities of mural and house clocks; and in the fabrication of monumental and decorative clocks France occupies the first position.

The principal producing centers in France are Paris, St. Nicolas d'Aliermont, near Dieppe; Cluses, in Savoy; Besançon, Montbeliard, and Morez, in French Comté. The large monumental clocks are made in Paris; and until recently the provincial establishments, especially St. Nicolas and Montbeliard, also sent to that place or to Switzerland the pieces for many other descriptions of clocks and watches to be there put together and finished. Foreign competition has caused a change in this system, however, and the tendency is toward the completion of the clock or watch on the spot.

The great change noted in this industry since 1878 is the increasing substitution of machinery for manual labor in the European countries.

The serious competition in foreign markets offered by the American machine-made watches and clocks was long ago recognized. But it was at first supposed that, while the machinery system was necessary in America on account of the high rate of wages of skilled workmen and the relatively small number of such persons, its application was limited to the common class of articles. In a measure this was true, and even to-day the finest and most delicate work is that accomplished by hand, which has among other advantages that of avoiding molecular disturbances of the metal.

Clock and watch machinery has, however, been so constantly and ingeniously improved, and its scope has been so widened that it has become applicable, not only in the fabrication of fine watches as well as cheap, but also in the more delicate parts of the mechanism. To meet the competition of the American products that were found to be gaining more and more foothold in the foreign markets, the European countries have been gradually compelled to adopt the mechanical method, and it is now very generally used in France, in Switzerland, and in England. Especially in Switzerland and France, the great efforts made to regain possession of the domestic and foreign markets are thought to have met with a corresponding degree of success, and it is claimed that, coincidently with a lowering of

price, there has been a marked improvement in quality of both fine and cheap products.

As stated above, the maritime situation of England has always made that country preëminent in the fabrication of marine chronometers.

France and Switzerland also manufacture chronometers of very careful execution in respect to movement and escapement and the establishment of a spring, to which they generally give the Philipps theoretic curves, regulated by ordinary and auxiliary compensation. The advisability of substituting palladium for steel or gold springs of chronometers is not considered as definitely proven, in spite of its advantages in the matter of rust and magnetism, owing to the somewhat unsatisfactory elastic conditions of that metal.

Of astronomical pieces and regulators of great precision there was not a very large exhibit. Fenon exhibited in the French section several new devices and modifications of old ones, among which are a mercury compensation, with bottle of steel and a polished rod acting simultaneously; the application of a movable runner on the balance for the correction of small variations without touching the pendulum or stopping the clock; and regulators, with auxiliary mechanism, for transmitting the electric current every second for synchronous apparatus.

Fine watches, whether simple or complicated with chronographic and lunar apparatus, split second and fly-back needles, repeating the minutes, etc., had already attained in 1878 a degree of perfection leaving little to be desired. Although there is on very radical change in the principles employed, manufacturers now claim to show results heretofore unequaled in point of accuracy and regularity.

Most of these watches are regulated for six positions, and also for temperature, and the general tendency is to substitute the lever ("bascule") for the anchor escapement.

In many cases palladium has been used both in the composition of the spiral and the balance, in place of steel, with the view of rendering the watch antimagnetic, and it is said to have given satisfactory results. Some other antimagnetic metals or compositions, known as "Cadsumine," "Woltine," "Mangar," etc., were also used, and appeared to answer equally as well as palladium.

In the Swiss section several watches, having parts composed of various antimagnetic metals such as the above, were tested near a dynamo machine, and varied in their daily march but one second; the variation disappearing when the watches were removed from the disturbing cause. Owing to the increasing establishment of electrical appliances, the desirability of making watches nonmagnetic is generally recognized. In the American section one exhibit attained this by the use of cases of a peculiar composition or a band of the same metal surrounding the movement.

Of large monumental clocks the French section contained some very fine exhibits, employing the gravity escapement as well as that "à remontoir d'égalité," and with attachments for transmission of the hour by electricity.

In pieces entirely electrical, where the action of the spring and weight is replaced by electromagnetic force for the distributing clock as well as the receiving dials, the better application of the laws of electricity has rendered the system much more practical, and although the form of the apparatus has undergone no recent change of a radical nature, the results obtained are more satisfactory.

Several experiments in the pneumatic system, among which is one to utilize the action of a vacuum obtained by an escape of water, are not thought to have given good practical results.

The exhibit of small clocks, portable clocks, etc., was large and of fine quality and great variety of form. The pieces are almost entirely fabricated by machinery.

In the American section, in addition to the watch exhibits of the Trenton and Waterbury Companies, Tiffany & Co. exhibited an isochronal clock having a number of pendulums each with an escapement. These escapements are associated in the clock in such manner that a principal second hand gives constantly the average time indicated by the group of escapements. Great accuracy is claimed for this system.

The British section contained some apparently fine chronometers, watches, clocks, etc., but their exhibitors did not show any desire to afford information concerning them.

In addition to the very complete exhibit in the French section of clocks and watches of all descriptions and prices, there were many ingenious appliances for use on railways, the detection of watchmen, etc., among which may be mentioned Garnier's differential reckoners for regulating the movement of a squadron of ships in line.

Haas exhibited watches for use in the dark or for the blind, the figures indicating the hour being in relief on the face of the dial. The position of two auxiliary hands communicating with the regular hour and minute hands may be determined by the touch.

Bréguet also exhibited for the blind a watch with a double case independent of the watch proper. On placing the enveloping case in position the movement of the watch is ingeniously communicated and registered on the raised surface of the outside case.

Schwob et frère exhibited so-called mysterious watches with transparent dials, the relatively small mechanism being located in a section of the circumference immediately underneath the ring.

The change from manual to mechanical labor has necessarily modified the system of technical instruction in the apprentice schools, but has not affected their permanence or prosperity. In Switzerland almost all the centers of fabrication have industrial establishments

of this kind, while in France there exist the École de Cluses, subsidized by the Government, the École de Besançon, subsidized by the municipality, and the École d'Horlogerie de Paris, established and sustained by the "Chambre Syndicale de l'Horlogerie. There were excellent exhibits executed by the scholars of the above establishments.

L'École d'Horlogerie Genevoise furnishes both practical and theoretical instruction and is open to all nationalities, though at higher rates than for the Swiss. The theoretic and incidental instruction comprises mathematics, mechanics, draughting, elementary chemistry, physics, astronomy, and theoretical horology.

The practical instruction is divided into two divisions, in the first of which the apprentice acquires practice in making various parts of watches until he is capable of constructing anchor and cylinder escapements. The second division is intended for those wishing to perfect themselves in a special branch of the industry.

These two divisions include classes for the separate pieces of the watch or clock, escapements, regulation, finishing, and for construction by mechanical methods. The duration of the course is five years, three of which are spent in the lower division.

At Kew, in England, and Besançon, in France, observatories exist similar to the establishment at Geneva, where chronometers and watches of great precision may be sent by individuals or firms and the regularity of their movement officially determined and certified. The Geneva establishment is fully equipped for noting the variation in different positions and temperatures of the pieces submitted, and the annual reports interchanged are said to show superior results obtained by the watches examined at the Swiss Observatory. At this place the chronometers are divided into three categories, according to the greater or less severity of the tests. To entitle the piece to be "breveted" as "very satisfactory" in the highest or A class, the mean variation for twenty-four hours must be less than three-quarters of a second, the average variation corresponding to a change of position must not exceed two and one-half seconds, and the error of compensation for 1° C. must be less than one-fifth of a second.

In 1888, of 458 pocket chronometers presented for trial, 35 were returned to the maker for correction, 132 obtained certificates of ordinary, and 291 of very satisfactory movement. Of the 458 chronometers there were 201 of Class A, of which 48 were classed as ordinary, and 140 (or 70 per cent.) as very satisfactory.

CLASS 27.—APPARATUS AND PROCESSES FOR HEATING—APPARATUS AND PROCESSES FOR LIGHTING OTHERWISE THAN BY ELECTRICITY.

GENERAL REMARKS ON METHODS OF HEATING.

There was a varied exhibit of portable stoves and appliances used by the poorer classes for heating on a small scale. Although condemnable in principle, and doubtless the cause of much sickness, the small stove is to a great extent a necessary evil, and, especially in France, is in very general use. Improvements and modifications involving expense are precluded in this class of articles, whose first recommendation is their cheapness, and in general they possess the same features, consisting of a grate surmounted by a receptacle for the combustible material. The constructors of small stoves have endeavored, however, by such simple contrivances as are possible, to mitigate the objectionable points; with this end in view the size of the feed opening has been diminished relatively to that of the chimney in order to avoid checking the draft and a consequent escape of gas into the room at the moment of refilling. The best stoves of this description were exhibited by Cadé and by Simpson (United States). In the former the grate can be raised or lowered, and the quantity of fire regulated accordingly.

For heating on a larger scale, private houses, etc., hot-air furnaces have been until recently in more general use than any other system. In such appliances the combustion is usually effected in the interior of a bell so ridged or bladed as to increase the heating surface; and being rapid does not generate much oxide of carbon gas.

The tendency at present, however, is to substitute for the above hot-water heaters furnished with the necessary indicators, valves, and cocks for a systematic and independent heating of separate parts of the house. The hot-water coils exhibited in the French section were generally furnished with blades or disks increasing the heating surface.

Several furnaces were shown, adapted for burning waste materials of various descriptions, coal dust, trash, etc., among which may be mentioned the system of Geneste-Herschel, composed of two graduated grates; one fixed, the other movable. A feed-hopper, with an outlet that can be regulated at will, furnishes an automatic feeding. Godillot exhibited a furnace in which a continuous automatic feed is effected by means of a spiral screw that distributes the combustible matter over the surface of the grate.

The system of heating by means of hot water under moderate pressure has the following advantages over the hot-air method:

(1) The certain avoidance of a casual mingling of the air destined for breathing with the furnace gases. This separation is more than

ever important when economic slow combustion furnaces are employed, giving rise to considerable quantities of oxide of carbon.

(2) The suppression of the hot-air passages, almost impossible to clean by reason of their inaccessibility.

(3) The possibility of distributing the heat in the room in a rational manner; *i. e.*, by placing the heaters near doors or openings where the greatest loss of caloric takes place, and thus avoiding drafts along the cold walls.

(4) The moderate degree of heating to which the air is subjected, and the consequent preservation of its vital properties.

In these apparatus the circulation of the water is due to the difference in densities of the series of hot and cold columns, and is necessarily slow. A system to accelerate the movement of the water, and carry it to greater distances by an injection of steam, was exhibited by Cuan. It has, however, the disadvantage of inconvenience and expense attending the use of steam in a private establishment.

In the "aero-condenseur" exhibited by Fouché, the exhaust steam from the cylinders of an engine is condensed in a nest of pipes surrounded by air blown in by means of a fan. The heated air is then impelled to the room it is desired to heat. This is in fact a hot-air heater; but its effectiveness is limited by reason of the necessarily low temperature of the air on emerging from the condenser.

So far no apparatus using steam only has been sufficiently simplified to make it adaptable for use in private dwellings.

For heating on a large scale—theaters, public buildings, schools, etc.—both hot water and steam apparatus are used. The essential features of the former are a boiler for heating the water and pipes for its distribution, heating surfaces, and, finally, an expansion vase or reservoir intended for the dilatation of the water. The system is known as with or without pressure, according as the expansive vase is of closed or open construction. In the latter case, the temperature of the water being limited to 212° F., the circulation is not very rapid, and must be compensated for by a corresponding increase in volume obtained through larger pipes. This system consequently compels the movement of a considerable liquid mass, is therefore cumbersome, and gives rise to difficulties in accommodating itself to extreme variations of temperature.

To increase the rapidity of circulation, Chibout showed a boiler surmounted by a reservoir, from the under part of which the general supply pipe runs. From the top of the reservoir runs another pipe furnished at its foot with a ball valve opening outward. The return pipe is on the contrary supplied with a valve opening inward. Being heated, the water is unable to circulate freely, owing to the valves. Steam is generated in the reservoir until the pressure becomes sufficient to force the valve on the supply pipe and the col-

umn of water surmounting it. Thus the circulation is established and continues until the pressure in the reservoir over the boiler is no longer sufficient to raise the valve, when it is suspended until enough steam is generated to continue the operation. The drawback to this system would seem to be its intermittent action.

In the system "with pressure," where the water can be heated to considerably more than 212° F., the quickness of the circulation and temperature of the water being both increased, a smaller volume of water is necessary, and the accessories of the apparatus become less unwieldy.

In the drying department of the national powder manufactories of France, where a great regularity of temperature is desirable, hot water is made to circulate very rapidly by means of centrifugal pumps operated by dynamos, and the temperature of the water on emerging from the pipes is only 5° C. lower than on entering.

The steam-heating system proper, used in large buildings, possess almost all the advantages of the hot-water heaters, with the additional valuable feature of enabling the transmission of the heat to much greater distances.

The latest modifications and improvements in steam heaters were well shown in the exhibits of Geneste-Herschel and Grouvelle in the French section.

Grouvelle suppresses the parts known as purgers, and is therefore obliged to distribute exactly the needed amount of steam. To accomplish this he uses "diaphragms" pierced with a hole of diameter varying according to the quantity of steam to be supplied. This diameter is so regulated that with a maximum pressure of about 2 kilogrammes in the distributing pipes the quantity of steam passing out is sufficient for the coldest days without any escape of steam into the return pipes. In very cold weather the entire length of the heating surfaces is utilized, in milder weather a portion only. By an ingenious but intricate contrivance the temperature is regulated automatically.

In the apparatus of Geneste-Herschel, on the opposite end from that by which the steam enters, the heating surfaces are closed by "purgers" that operate under the influence of the temperature and allow the evacuation of the air and condensed water when the heating begins. The steam, however, is always contained and can not pass into the return pipes.

This system has the advantage of allowing each part of the building to be separately regulated by means of a coil filled with a liquid whose changes of density under variations of temperature enable it to act directly on a slide valve that governs the introduction of the steam.

For theaters and large halls the tendency seems to be, for hygienic reasons, to heat the passages and vestibules; this being being accom-

plished and the interior of the walls of the theater being thus warmed, the body of the house requires nothing more than ventilation with barely tepid air. At a moderate temperature the air may be introduced without inconvenience or danger in close proximity to the individuals, under their seats, etc.; when vitiated it rises, and is evacuated above.

Of the two methods of ventilation, that by suction or that by insufflation, the latter is recognized as the better and is generally adopted.

The foreign sections contained nothing in the shape of kitchen ranges requiring notice; but there was a large and varied display of such appliances in the French section proper, in the annex to Class 27, and in the Gas pavilion.

The Simpson stove, of American invention, but manufactured in France, and consequently exhibited in the French department, has already been referred to in its capacity as a heater; it is also furnished with attachments for cooking, roasting, etc., and seemed altogether the best of the articles of its description exhibited.

Cooking apparatus of all sizes were shown operated by direct fire, by steam, and by gas.

Bougnodet et Garnier exhibited a range adaptable either to fire or gas. When the latter is used, the vessel to be heated depresses by its weight a button, thus admitting the gas which is lit by a small jet burning constantly. On removing the vessel, a counterweight raises the button and cuts off the gas.

Egrot exhibited a convenient appliance for cooking on a large scale by steam, consisting of vast kettles (provided with false sides and bottoms for the circulating steam) grouped around a central axis. The whole can be readily moved, and is specially intended for military hospitals, schools, barracks, etc., or temporary large banquets.

The ordinary kitchen ranges shown possessed various small improvements and modifications, but most of these features were not sufficiently novel or remarkable to make a detailed consideration necessary.

LIGHTING BY MEANS OF GAS.

In an elaborate building erected for the purpose "La Société Technique de l'Industrie du Gaz" showed the application of gas to all the wants and requirements of the modern household and those appliances thought to be best calculated to supply them. The building covered 428 square metres, and was, in fact, a luxurious house completely furnished from top to bottom.

The basement contained gas-motors of the types most used in France, including the "Forest," the "Lenoir," the "Rouvel," the "Otto," and the "Benz." These were not placed merely as an ex-

hibit; some operated centrifugal pumps for supplying water to the different stories; one worked the elevator, and another operated the Edison electric machine that served for lighting one of the rooms.

The kitchen was supplied with a large gas-range presenting all the possible automatic conveniences, and was illuminated by gas-burners of the Wenham type on the recuperation and ventilation system, the products of the combustion passing out through special openings contrived for the purpose in the ceiling. The vestibule of the first story was lit by two figures holding gas-torches and a powerful recuperating light placed in the ceiling. The library was also illuminated by a cluster of recuperating burners, and the reception room was furnished with candle-burners and recuperating burners of the Cromartic type. The billiard room derived its light from above by a luminous cornice, instead of by burners directly over the table, and the dining room was illuminated by a cluster of recuperating burners, placed near the ceiling for ventilation purposes.

One of the halls contained an interesting retrospective exhibit of appliances for lighting, from the old Roman lamp to the chandelier of to-day.

The principle has been well established for some time that either in private houses or public halls a good gas installation must evacuate the products of the combustion and employ the heat otherwise lost in aiding ventilation. A special construction of flooring and ceiling is of course necessary in such cases, and special care must be taken to avoid accidents resulting from an accumulation of escaped gas, which is not so easily detectable as when no direct ventilation is attempted.

The great improvements accomplished in electric lighting in the last few years, and its constant encroachment on the fields heretofore occupied by gas, oil-lamps, and other means of lighting, have stimulated advocates of the latter to greater efforts tending toward economy and the attainment of a purer and more effective quality of flame.

A great variety of "moderators," "regulators," etc., was exhibited in the French section, the object of the former being to burn the gas at a low pressure and that of the latter to assure a constant and equable supply for the burner independent of the pressure in the main gas-pipe.

Coincidentally with the progress in electric lighting, the improvements made both in the refining of petroleum and in the lamps for burning it have offered in the last few years a competition to gas which must have driven the latter completely out but for the contrivance of better and more economical burners. Thus the carcel or unit of light adopted by the gas industry corresponded in Paris, before the introduction of intensive burners, to an hourly consumption of 105 litres of gas burned in a Bengel burner. By means of

the intensive burners the carcel is now obtained for 50, 40, and even 35 litres per hour. The idea of obtaining greater luminous effect by a better combustion of gas through preliminary heating of the air was not entirely new, having been partially applied by Chaussenot in 1836.

In 1880 Siemens, of Dresden, contrived, following the above principle, the recuperating burner which bears his name, and practically revolutionized gas apparatus by producing light of 20, 30, and 50 carcels with a consumption of 50, 40, and even 35 litres per carcel. In 1885 the Wenham burner appeared in England. This burner is also constructed on the recuperation of heat system, and is withal compact and not ungraceful. It obtains a carcel with a consumption of about 35 litres of gas, and its form makes it readily adaptable to the evacuation of the products of combustion.

Since the introduction of the Wenham in France the models of intensive recuperating burners have multiplied, and they represent to-day the most advanced and best type of gas apparatus. In the Wenham burner the gas flame projects downward, and its luminous intensity varies according to the size from 2 to 20 carcels.

Electrical incandescent lamps suggested the feasibility of employing the calorific properties of gas for raising to a high temperature certain refractory substances and obtaining a white fixed light. This mode of lighting has been for some time roughly utilized by white-heating a little block of chalk by the combustion of gas and oxygen. In 1882 Clamond devised a burner in which the combustion of gas takes place in the interior of a wick of magnesium; this apparatus has not yet attained the results expected from it, but was succeeded and surpassed in 1885 by the invention of Welsch, in which the incandescent body consists of a small cone having the appearance of a light gauze; heated by a Bunsen burner beneath, this cone prepared with metallic oxides produces a brilliant light, and obtains 1 carcel for 40 litres of gas per hour; the cone lasts for 800 hours, and can be renewed without expert help. An economy of 60 per cent. over the best Argand burners is claimed for this system.

The following figures show the total gas production in France for the past eleven years, in cubic metres:

1878.....	430,700,000	1884.....	576,700,000
1879.....	467,500,000	1885.....	589,100,000
1880.....	507,800,000	1886.....	600,700,000
1881.....	536,200,000	1887.....	610,000,000
1882.....	560,000,000	1888.....	628,000,000
1883....	575,000,000		

In 1878 the number of French towns lit by gas was 687, containing 9,943,400 inhabitants. In 1888 the number of towns was 1,001, containing 12,680,000 inhabitants; the consumption having increased from 80 cubic metres per capita in 1876 to 107 cubic metres in 1888.

The extent to which gas is used for heating, cooking, and motive purposes is evidenced by the fact that in Paris one-fifth of the gas manufactured is consumed during the daytime.

The figures given above, and the extent to which gas was employed in lighting the various buildings of the Champ-de-Mars, would indicate that that industry is making a determined and intelligent effort to hold its own against electricity, by the invention of appliances cheapening the cost and increasing the effectiveness of its light, and mitigating objectionable features such as the consumption of the air of the apartment and wasteful irregular flow.

The arches and platforms of the Eiffel tower were lit by 4,000 gas jets; the Central Dome by 3,800, and the Trocadéro Palace, on nights of general illumination, by 59,962 burners; the consumption of gas per hour in the entire Exposition being 7,000 cubic metres.

Renard, Hubert & Co. exhibited an appliance adaptable to gas-burners, and increasing the carburation by the use of "albo-carbon." Albo-carbon, or white carbon, is a substance with a naphthaline base, purified in some special manner. This is placed in a small bowl or reservoir through which the gas passes on its way to the burners. This reservoir is hermetically closed, and its surface is heated by a small gas jet lit simultaneously with the burners. Thus the naphthaline is melted, and its vapors mingled with the gas effect a complete carburation of the latter, and produce a light of great steadiness and brilliancy.

Bourrey exhibited a tubular recuperating burner formed of a porcelain cone, inclosing a brass cone closed at the top, and in which the gas must penetrate before making its way to the orifice.

The Wenham Company exhibited a great variety of burners adapted to theaters, concert halls, etc., where they are so arranged as to assist the ventilation, as in the Pavilion du Gaz, referred to above.

The English, Russian, Belgian, Italian, American, and other foreign sections contained a few exhibits of oil-lamps, lanterns, etc., and the French section had a large display showing an infinite variety of form and shape, but few new principles of importance.

Among the small improvements noticed was one by which the lamp could be lit, the wicks trimmed, etc., without removing the chimney or globe, which are lifted on the frame by turning a small lever.

MATCHES.

The invention of the safety match, the substitution of machines for hand labor, and a better combination of inflammable chemicals in the ordinary match, were all signalized previous to the Exposition of 1878.

Since that time there has been no radical change in this industry beyond improvements of a detailed character increasing the effective-

ness of the machines and cheapening the cost of the product materially. The wax matches manufactured in France are as far superior to those made in the United States as their common wood matches are inferior to ours. "La Compagnie Générale des Allumettes Chimiques pour la France et l'Étranger" showed the materials used in fabricating their matches and boxes, models of the machines for cutting the wood, and sketches of the closed vases in which the chemical pastes are mixed.

CLASS 28.—*PERFUMERY, SOAPS, ETC.*

The excellence of France in this industry is due both to the great number of aromatic plants and flowers that grow under her temperate climate and to skill and care in preparing the products.

Most of the raw materials used are in fact of French origin, with the exception of various fragrant essences, essential oils, and aromatic substances derived from foreign countries. The rose essences come from Turkey, musk from China and English India, cinnamon from China, Japan, and Ceylon, fragrant gums and resins from Greece, the East, and Africa, balsam from Peru, benzoin from Siam. The recent and much prized *ylang* essence is from a newly opened portion of China. The Alps and Algeria contribute wild flowers, lavender, etc. The principal manufacturing center in France is Provence.

The great strides made in chemistry in the last few years permit a more rational use of the raw materials, and it is now claimed that, with the possible exception of hair-dyes and washes, the products of French perfumery are absolutely wholesome and free from all injurious properties.

The most serious competitors of France are England, Germany, Russia, and Italy; yet their combined production is only two-thirds that of France, whose annual output reaches 50,000,000 francs. Of this she exports 30,000,000, or about 15,000,000 francs more than in 1878.

For a long time England had, through her colonial relations, almost a monopoly in the purchasing of the necessary raw materials from foreign countries. Recently, however, many French commission merchants have adopted the course of accepting these raw materials in payment of goods exported; a plan which has resulted advantageously both to the producing countries and to France.

By means of new machines the soap pastes are now worked almost without water, thus obviating the long operation of drying. As the drying apparatus occupied a large space in the factories, its disappearance results in an economy of space, work, and time.

Apart from mechanical contrivances which have resulted in lowering the cost of production, and relatively ameliorating the product, there is to notice the substitution of neutraline or rectified

petroleum for the fats heretofore employed. This substance has the great advantage of not becoming rancid.

The president of the jury, Mr. Guerlain, shows in his exhibit the results of experiments made for extracting the various essences by means of a powerful dissolvent, chloride of methyle. On the question of its value, manufacturers are as yet divided in opinion.

The various extracts destined for sprinkling or use on the person are now so perfected as never to stain the linen.

The French perfumers do not favor transparent soaps, claiming that being manufactured by the cold process the alkalis retain their caustic properties.

CLASS 29.—LEATHER WORK, FANCY WOODEN ARTICLES, BASKETS, BRUSHES.

The exhibit in this class was both large and varied, and merits special interest from the fact that the sale of these products attains in France alone the high figure of \$30,000,000 yearly.

The class may be divided into: (1). Fancy leather work; (2) Brushes; (3) Stationery, carved ivory, etc.; (4) Papier-maché objects; (5) Combs; (6) Pipes and smokers' articles; (7) Basket work, and (8) Small fancy articles of furniture.

LEATHER WORK.

The principal European manufacturing centers are in Germany, Berlin and Hoffenbach; in Austria, Vienna; and in France, Paris. The United States also produce largely, but do not export.

In France this industry was seriously affected by German and Austrian competition about the time of the 1878 Exposition, but seems to have recovered a front rank, and now yields to none in elegance and variety as well as in cheapness of fabrication.

In the French section the most noteworthy exhibit is that of Amson frères, who employ eight hundred workmen, and have factories in Paris, Lyancourt, and Amiens. Their articles are prepared, sewed, etc., in the provincial establishments, enabling the manufacturer to take advantage of the cheaper rate of labor; the decoration and finishing are done in Paris.

Austria, though producing large quantities of fancy leather work, was not represented by anything specially new or noteworthy.

Tiffany & Co., of the United States, exhibited very handsome specimens of leather work, richly and tastefully decorated with metal, chiefly silver. Almost every animal skin that will supply a novel or useful decorative effect is employed by this firm.

BRUSHES.

In the fabrication of brushes, especially those in bone, France occupies a leading position. Dupont & Co. had an excellent exhibit; this house employs fourteen hundred workmen at Beauvais,

has branches both in England and America, and exports largely to the latter country.

The firm of Kent, of Great Britain, also a large one, showed brushes of all styles and of remarkable quality.

“TABLETTERIE,” CARVED IVORY, ETC.

The various small articles of stationery or ornament have undergone no great change since 1878, either in variety of design or in method of fabrication.

Moreau Vauthier exhibited carved ivory statuettes, ornamented with gold and silver, which possessed artistic merit.

Japan, Siam, and some other Eastern countries had specimens of great delicacy and minuteness. The subjects and designs, however, are always the same.

PAPIER-MACHÉ OBJECTS.

This industry is essentially French, and the last few years find its scope constantly increasing and competing successfully with Japanese lacquer-work. Adt frères exhibited a great diversity of objects made in this material, for which they received the highest recompense from the jury.

There is a large export trade in these articles, especially to the United States.

COMBS.

France still exports large quantities of combs, although almost all countries now fabricate for themselves. The ordinary qualities are made principally in the provinces, the finer in Paris. Since 1878 the manufacture of combs by hand has yielded to mechanical processes, and several new steam factories have been erected.

PIPES.

Though Vienna is the great center for the production of meerschäum pipes, the most elaborate and costly articles of this description are manufactured in Paris. This industry was introduced in the United States by Demuth, and his exhibit has been very favorably noticed.

Briar pipes are made chiefly in the province of the Jura, where their manufacture occupies almost the entire population of the canton of St. Claude. France may be said to have possession of the field for the better classes of these articles, which she sends to all quarters of the earth.

BASKET-WORK.

Articles of this description are generally made in the country by individuals, who sell their wares to the merchants. Recent efforts tending toward industrial and mechanical innovations and improvements are not reported as having been very successful.

FOURTH GROUP.

TEXTILE FABRICS, WEARING APPAREL AND ACCESSORIES.

[EXTRACT FROM THE OFFICIAL CLASSIFICATION.]

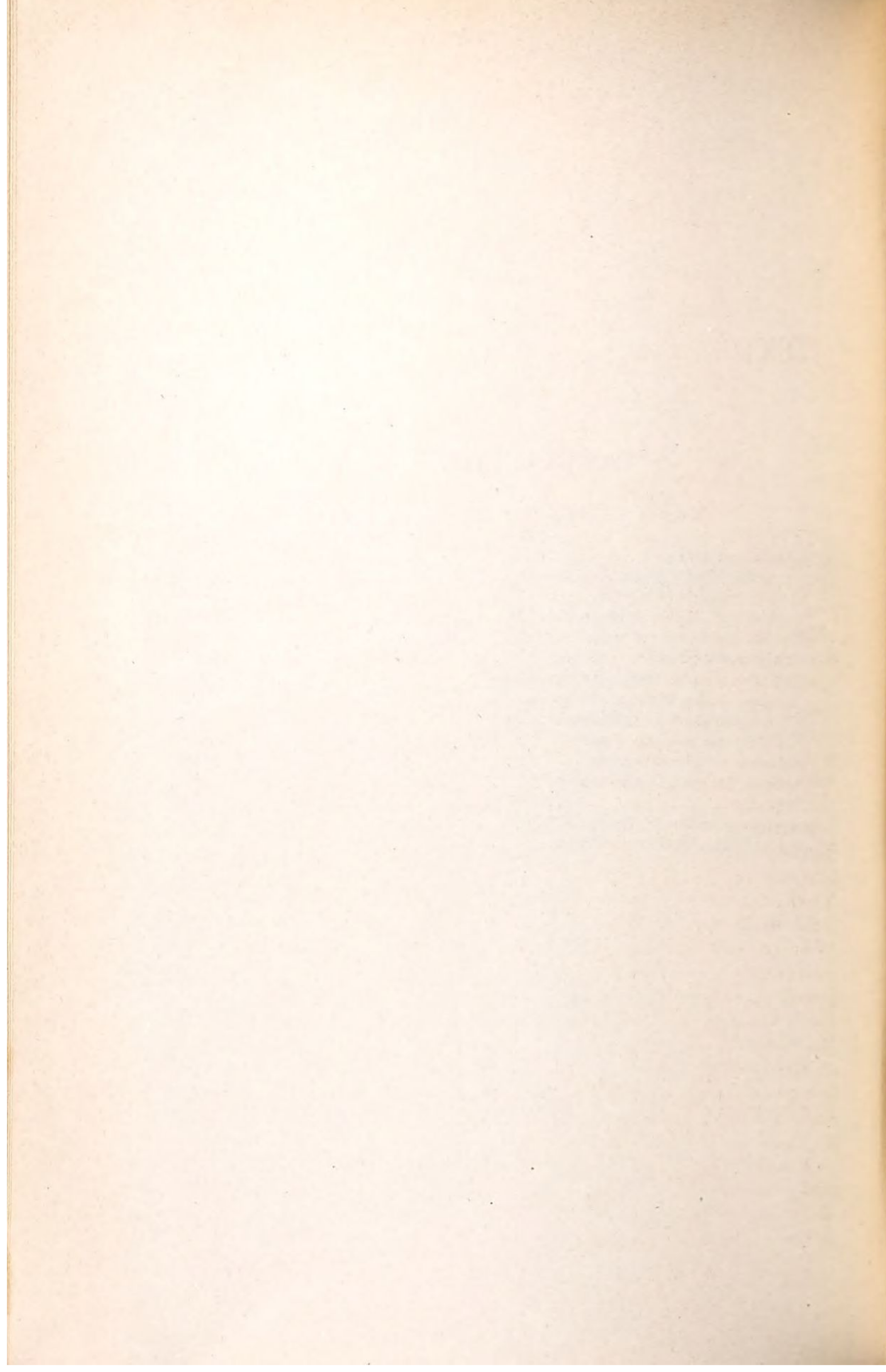
FOURTH GROUP.

TEXTILE FABRICS, WEARING APPAREL AND ACCESSORIES.

- CLASS 30. Cotton thread and fabrics.
- CLASS 31. Thread and fabrics of hemp, flax, etc.
- CLASS 32. Threads and fabrics of combed wool. Threads and fabrics of carded wool.
- CLASS 33. Silks and silk fabrics.
- CLASS 34. Laces, net, embroidery, and trimmings.
- CLASS 35. Articles of hosiery and underclothing. Accessories of wearing apparel.
- CLASS 36. Wearing apparel for both sexes.
- CLASS 37. Jewelry and precious stones,
- CLASS 38. Portable weapons, hunting.
- CLASS 39. Articles for traveling and camp equipage.
- CLASS 40. Toys.

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TEXTILE FABRICS WEARING APPAREL AND ACCESSORIES.

By W. H. CHANDLER, Ph. D., F. C. S.

This group includes nearly everything which is worn for comfort or adornment by either sex, and in addition portable weapons, traveling equipage, and toys. The exhibits were, therefore, very numerous. In these lines of industry France has long held the leading place, both in the excellence of manufacture and in the artistic and decorative qualities of its products. Of the two principal competitors of France in these lines Great Britain did very little and Germany was not represented at all.

Exhibitors from the United States received two grand prizes—namely, John B. Stetson & Co., of Philadelphia, Pennsylvania, for hats, and the Winchester Repeating Arms Company, of New Haven, Connecticut, for firearms.

Exhibitors from the United States received twelve gold medals, namely: Garner & Co., of New York, for cotton prints; Mayer, Strouse & Co., of New York, for corsets; Beneke Brothers, of New York, for boots and shoes; Dunlap & Co., of New York, for hats; Schloss & Co., of New York, for children's clothing; Secretary of War, of Washington, District of Columbia, for exhibition of historic uniforms of the American Army; Tiffany & Co., of New York, for jewelry; Colt's Patent Fire Arms Manufacturing Company, of Hartford, Connecticut, for firearms; Smith & Wesson, of Springfield, Massachusetts, for revolvers; Union Metallic Cartridge Company, of Bridgeport, Connecticut, for models of ammunition; Boston Rubber Shoe Company, of Boston, Massachusetts, for rubber boots and shoes; Marks' Adjustable Folding Chair Company, of New York, for adjustable folding-chair.

A numerical list of the exhibitors and of the awards of grand prizes and gold medals is appended as being of interest to those studying the management and administration of such international exhibitions. The juries making the awards were careful in their exami-

nations and just in their decisions. These decisions as to the merit of the exhibits are based upon the following features:

(1) Great novelty of invention either in the exhibit or process of manufacture.

(2) Great excellence of the exhibit or product.

(3) Magnitude or extent of the establishment.

(4) Awards were given also for collective exhibits of merit or exhibits of collections.

(5) Awards were also given in some cases for the encouragement of industries new to the particular locality in the absence of either novelty or special excellence.

There may be named, perhaps, as fair examples of these various awards, the following grand prizes in Classes 41 and 48:

(1) Percy C. Gilchrist, of Great Britain, for the basic process of the manufacture of steel.

(2) Marrel frères (Forges de la Loire et du Midi), France, steel and iron forgings.

(3) Société des mines et founderies du zinc de la Vielle Montagne, France et Belgique, products of zinc.

(4) Exposition collectif des forges du Nord, France.

(4½) Administration Royale Grand-ducale des Mines, Grand Duchy of Luxembourg.

(5) Compagnie Minière des lettres, Venezuela.

These are selected merely as illustrations of the system, which is equally applicable to any other department or class, and as the most satisfactory basis of awards of these great international exhibitions.

Lastly, awards were given to collaborators—employés who have contributed to the production of the exhibit. For instance, George F. Kunz, employed by Tiffany & Co., and who collected the specimens of semigems and minerals in their exhibit, received a gold medal. Dr. L. M. Biber, who collected the mineral exhibit of the State of Nevada, received a bronze medal.

NUMBER OF EXHIBITORS.

Country.	Class.											Total.
	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	
Argentine Republic	3	5	33	3	15	14	17	1	4	5	.....	100
Austria	2	2	4	.....	.....	20	24	19	.....	1	.....	72
Belgium	17	27	29	7	25	17	17	7	22	2	14	184
Bolivia	4	.....	11	.....	4	.....	3	8	.....	1	3	34
Brazil	9	3	3	5	11	6	16	2	1	3	.....	59
Cape Colony .....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1
Chili	1	1	4	.....	5	5	10	.....	1	2	.....	29
China .....	.....	.....	.....	2	1	.....	.....	.....	1	.....	.....	4
Denmark .....	.....	.....	.....	.....	6	1	3	.....	.....	.....	.....	10
Egypt .....	.....	.....	.....	3	3	.....	2	1	2	.....	.....	11

NUMBER OF EXHIBITORS—Continued.

Country.	Class.											Total.
	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	
Ecuador	3	4	5	.....	3	1	5	.....	2	3	.....	26
France	182	77	189	187	164	280	313	163	57	54	105	1771
Colonies	9	18	22	16	17	32	124	42	46	46	8	380
Protectorates.....	6	3	1	12	5	8	17	8	18	4	1	83
Great Britain.....	12	5	20	19	13	20	31	8	16	13	6	163
Greece	53	7	17	56	43	25	41	6	8	5	2	263
Guatemala.....	13	8	22	3	23	2	34	.....	1	1	1	108
Holland.....	.....	1	.....	.....	.....	1	2	.....	.....	1	2	7
Hawaii .....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	.....	2
Italy.....	.....	2	.....	14	4	3	5	38	.....	.....	.....	66
Japan.....	6	1	1	55	2	17	3	6	.....	.....	4	95
Luxembourg .....	.....	.....	1	.....	1	2	.....	.....	.....	.....	.....	4
Monaco.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
Norway .....	.....	.....	.....	.....	10	2	3	3	.....	1	1	20
Paraguay.....	1	1	.....	.....	15	7	.....	1	1	3	.....	29
Portugal.....	11	4	15	5	7	10	36	.....	1	.....	.....	89
Colonies.....	3	.....	2	.....	1	2	2	.....	1	.....	.....	11
Roumania.....	13	14	43	45	9	33	57	4	.....	4	.....	222
Russia	18	5	15	10	7	7	13	3	5	1	.....	84
St. Domingo.....	.....	.....	.....	.....	1	4	4	2	3	2	.....	16
St. Marin.....	.....	1	.....	.....	5	.....	.....	.....	.....	.....	.....	6
Salvador.....	3	1	.....	3	11	3	18	4	.....	1	.....	44
Servia.....	16	11	77	14	32	240	36	.....	3	.....	.....	429
South Africa republics.....	.....	.....	.....	.....	.....	1	1	1	1	.....	.....	4
Spain.....	10	6	47	5	8	16	27	3	1	2	2	127
Sweden .....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1
Switzerland.....	2	.....	1	17	32	16	10	7	3	1	.....	89
United States.....	7	4	8	2	3	8	12	8	6	6	5	69
Uruguay.....	.....	.....	.....	4	.....	1	6	.....	.....	.....	.....	11
Venezuela.....	1	1	.....	.....	4	.....	3	2	1	.....	.....	12
	405	212	571	487	490	805	897	348	205	162	154	4,736

GRAND PRIZES AWARDED.

Belgium	2	3	1	.....	3	.....	.....	.....	2	.....	.....	11
France.....	3	2	10	26	8	4	3	4	5	.....	1	66
Colonies.....	.....	.....	.....	.....	2	.....	.....	.....	1	.....	.....	3
Great Britain.....	1	1	.....	.....	.....	.....	1	.....	2	.....	.....	5
Italy .....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Japan.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1
Russia.....	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
Spain	2	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	3
Switzerland.....	1	.....	.....	3	1	.....	.....	.....	.....	.....	.....	5
United States.....	.....	.....	.....	.....	.....	.....	1	.....	1	.....	.....	2
	12	7	12	30	14	4	5	4	11	.....	1	100

GOLD MEDALS AWARDED.

Country.	Class.											Total.
	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	
Argentine Republic.....			1									1
Austria			1			1	4	1				7
Belgium	8	3	10	1	7	3	4	1	8			45
Brazil	2						1					3
Cape Colony.....								1				1
Denmark					1		1	1				3
Ecuador.....							2					2
France.....	26	29	41	44	28	35	46	29	15	14	5	312
Colonies	1		1		6		4		2			14
Great Britain.....	3	1	2	7		1	6	1	6			27
Greece.....				1			1					2
Holland.....										1		1
Italy.....				2				3				5
Japan.....				10	1							11
Mexico.....	6		1		2		3					12
Portugal	2				2	1			1			6
Roumania.....							2					2
Russia.....	3	2	1	4	1		2					13
Servia.....							1					1
Spain	1		2	1	2		4					10
Switzerland.				7	10	4	2	2				25
United States.....	1					1	4	1	3	2		12
Uruguay.....							1					1
	53	35	60	77	60	46	88	40	35	17	5	516

TEXTILE FABRICS WEARING APPAREL AND ACCESSORIES.

REVIEW OF GROUP IV.

By A. VAN BERGEN.

Those of our countrymen who came to France in the memorable summer of 1889, and their number is legion, have returned to America literally dazzled and astounded.

The splendors of the Paris International Exhibition were like so many fairy scenes, and now that they are over and the Exhibition deserted we seem to be awakening from a dream, a dream in which everything was grand, imposing, and stupendous. Even empty and deserted as it is, the Exhibition still interests us, for it would appear, even to those who have visited it most, that so many things have been left unseen, so many beautiful scenes passed hurriedly by, that they would gladly begin afresh and go over and admire it all once more.

The Paris Exhibition has had the good fortune, after six months of unparalleled success, not to have wearied our admiration, nor has it fully satisfied our curiosity, for it has closed its gates in a perfect apotheosis.

The Americans who came to Paris will, therefore, no doubt be glad to be reminded of that beautiful place after the lapse of four or five months, for it was indeed so beautiful we might go on speaking about it continually, while to those who have been prevented by business or pleasure from coming to the Exhibition I hope to be able to say something interesting, notwithstanding the excellent articles published by the American press.

I am not aware that the remark has yet been made, but in any case there can be no harm in repeating it. Americans have had two reasons for profound satisfaction in Paris. The first is, the prominent position we have taken in art and industry as compared with the other nations of the world, and the second is, the sincere and large-hearted sympathy we have met with at the hands of the Government, the country, and the people themselves. Our flag, borne aloft by General Franklin, has everywhere commanded the deepest and most sincere respect, while those of us, who have been called

upon to serve on the different juries for awarding prizes, are unanimous in speaking in terms of the highest praise of the flattering reception we have everywhere received and the unvarying kindness with which we have been treated. The fact remains undisputed that the Exhibition of 1889 has in every way greatly strengthened the bonds of friendship which have united America and France for the last century, and their two great centenaries, following so quickly one upon the other, mark not only the final triumph of liberty, but the glorious commemoration of the great civil struggles in which each country has taken part. And now, having made these preliminary observations, let us see what is the present state of that strange, weird, brilliant world which was the Exhibition.

Eiffel's Tower, the Central Dome, the Fine Arts Palace, the Liberal Arts Palace, the Machine Gallery, a few among the rare and curious little buildings put up by the tropical countries, and perhaps also a few pages of Garnier's History of Human Dwellings, these are all that are to remain of the immense hive through which 25,000,000 visitors have passed in the dust of the long sunny days of summer.

The *objets d'art* have been returned to the various museums, and those masterpieces of workmanship which were so much admired may be met with in every country; many have been sent to America and to England, if we judge from the notices posted up giving the names and addresses of the purchasers. The goods began to be sent away on the 7th of November, so that there will soon be partial exhibitions almost everywhere of the most remarkable exhibits of the Champ de Mars. These exhibits may, I think, be fairly said to represent the accumulated perfections in taste, grace, elegance, and richness of every branch of industry.

The large dry goods houses of London, Liverpool, Glasgow, New York, Boston, Philadelphia, Chicago, Rio de Janeiro, Madrid, Brussels, and other large towns are now showing the dresses, embroideries, hats, fabrics, flowers, jewels, glass, and porcelain goods bought at the Exposition, so that this great object lesson that Paris has given to the world at large will soon be repeated in almost every country. No one, I am sure, will say for one moment that such lessons are not eminently useful; nay, more, I think in all this I see a new era open before us, one in which art will be popularized and people's tastes elevated; surely, such results are not to be despised. In any case, this pause before the end of our century to note down and, as it were, to take stock of the world's goods is one never to be forgotten. But apart from the great moral and political conquests made during the nineteenth century, we must bear in mind that the marvelous applications of steam and electricity date from it. Compare the "Rocket" which was on view in the Gallery of Liberal Arts, with those colossal steam engines shown in the Machine Gallery, and then you will be able to form some idea of the progress

made. What strides we are taking! If we keep on at this pace the next generation will see some wonderful things.

Before proceeding any further, and while upon the threshold of this work, which I must say I have undertaken rather reluctantly, I should like to make just one remark. In the course of my rambles through that immense Exhibition, above the noise of the machines, the busy hum of the multitude, the strains of music, and the deafening roar of the steam engines, there seemed to rise, high above and over all, one grand idea, and that was, man's great guiding star, art. Never since the day I came to Europe, nearly forty years ago now, never have I been so deeply impressed with this thought. This impression has enlightened and edified me, both as to my daily occupation and with regard to French commerce and manufactures; it has given me a fuller perception of the powerful aid that art lends to human labor.

Group IV, the one I am about to review, includes goods of all kinds, upon each one of which art has put its stamp. There is an old saying "every French manufacturer is half an artist," and it has never been so true as for those exhibiting in Group IV.

Group IV comprises eleven classes, namely, from Class 30 to Class 40. The goods embraced were textile fabrics, made-up garments, and accessories, and it contained several thousand French and foreign exhibits:

Class 30. Cotton thread and fabrics.

31. Thread and fabrics of hemp, flax, etc.

32. Threads and fabrics of combed wool. Threads and fabrics of carded wool.

33. Silks and silk fabrics.

34. Laces, net, embroidery, and trimmings.

35. Articles of hosiery and underclothing. Accessories of wearing apparel.

36. Wearing apparel for both sexes.

37. Jewelry and precious stones.

38. Portable weapons, hunting.

39. Articles for traveling and camp equipage.

40. Toys.

In a word, everything relating to personal ornament or protection, defense, or amusement. If I were to quote figures I could show that these industries absorb more than one-third of the labor of all humanity, as proved by the amount of wages paid; they employ several millions of persons, of whom women form a considerable proportion.

The reporters of these eleven classes are now hard at work drawing up their reports, and it must not be supposed that they imagine they have an easy task. It almost seems as if they exaggerated its importance, they appear to be so thoroughly absorbed in their work. If I am not mistaken, we shall have a batch of thick volumes, of from 500 to 600 pages each, in a short time, and I am convinced that they will be full of interesting, readable matter and contain historical and

economical statistics of great value. For my part, I am pleased to see these literary efforts on purely commercial subjects. King Labor will in future have his historians and his staff of reporters. We shall be told how he lives, produces, and triumphs. We shall know how each industry has commenced and what progress it has made. Its most illustrious names will be sounded from shore to shore. Its decisive battles will be minutely described, while the days of its memorable struggles will be red-letter days for all, and we shall find our greatest pleasure in reading such literature, far greater, I presume, than in reading descriptions of those terrible massacres called glorious victories, which are so frequent in the history of past generations. There are, moreover, many reasons why these works should be read, and well read, for I think they will be written conscientiously by competent men, and that they will contain much valuable information drawn from the most authentic sources. I wish it therefore to be distinctly understood that the few remarks I am about to make have no reference whatever and do not in any way clash with the works I have just referred to. I shall not pretend to do more than set forth my views briefly as a business man, an American, and one of the oldest members of the American colony in Paris, and I shall confine myself to a few remarks on the progress and the future of some of the principal trades which have grown to importance in France and certain other countries.

There will obviously be (not in this paper, but in the works above referred to) a most perceptible gap resulting from the nonparticipation of Germany in the Exhibition. Germany competes keenly with France, England, Belgium, and other countries, which might, perhaps, have learned a valuable lesson had its manufacturers brought the products of their ingenuity to this great international congress; but the animosity still existing between the two peoples is far from subsiding; and it must be admitted at the same time that the English themselves, although on good terms with the French, by no means sent fair average specimens of their immense industries. Bradford, Manchester, Nottingham, and many other towns were, with few exceptions, only represented by agents.

It must not, however, be supposed that it is possible to form an accurate idea of human industry in every latitude and in every variety, even should we visit all the exhibitions in the world. I will say once more, because I wish to be clear on that point, the Paris Exhibition of 1889 has been the true expression of the most perfect beauty and richness to which man has yet attained in any of his works, and still the ordinary run of goods of everyday sale, those which in fact form the basis of international exchange, were only represented by a few scattered samples. I am therefore afraid that merchants and manufacturers, importers and exporters have gone away with very slight information on many subjects relating to their

various occupations, so that it is not possible to discuss these matters thoroughly and make useful comparisons, if we are to confine our remarks to articles shown in the Exhibition. The Exhibition has been an imposing object-lesson for the masses. That has been its best side, for the results of that lesson will remain long after the Exhibition has been forgotten.

I shall now proceed to give a brief summary of the exhibits, taking one class after the other. I shall have to quote certain names in order to make my observations as clear as possible, and I shall no doubt be obliged to speak very highly of many classes of goods, for, indeed, they call for terms of the highest praise. I am fully persuaded that any man, placed as I was in a position to judge, would say the same.

I lay aside all ideas previously formed, whether abstract, political, or innate, and take my stand exclusively as a commercial man. I have not trusted to my own judgment in this matter, but have consulted competent men in each branch of trade, so that I feel justified in the hope that these observations will contain impartial criticisms and accurate opinions, and that they may to some extent prepare your readers for the authoritative reports.

CLASS 30.—COTTON THREAD AND FABRICS.

This is one of the largest and most important industries in the world, and perhaps the one which interests humanity to a greater degree than any other; it is in fact the dominion of King Cotton. The applications of cotton seem unlimited; it forms the basis of such a vast variety of trades, all of which manufacture for the million; for as cotton fabrics are the cheapest of all textiles, they are adopted as coverings by hundreds of millions of human beings. Grays, bleached goods, dyed and printed calicoes play an important part in every climate, either as garments or drapery.

Considerable progress has been made in the weaving and printing of cotton fabrics. As fast as cotton makes its way, flax is driven out of the market. Cotton is continually pushing linen out, for although the latter is more durable, it is dearer, and so is obliged to make way for the lower priced article; this battle is always going on, slowly but surely. It is made up in widths ranging from 0.80 centimetres to 3 metres, the wide widths being for sheets.

Before the Franco-German war the cotton trade was most prosperous in Alsace, and more especially at Mulhouse, where such names as Dollfus, Mieg, Hartmann, Koechlin, Schlumberger, Gros Roman, and many others, were household words. Thousands of operatives were employed, and the mills covered hundreds of acres. When peace was signed they were very much cast down; they were extremely patriotic, and felt terribly aggrieved. Well, after all, they

could not take their country away and were obliged to make up their minds to it. A few amongst them, Gros Roman, Ch. Mieg, and Hartmann & Son., for instance, who have just been awarded gold medals, started new mills on French territory, and their patriotism has been crowned with success.

Amongst the grand prizes I may mention the name of Dollfus-Mieg & Co., but they have obtained it for their well-known yarns, and not for their cloths, which latter are made in Alsace.

The three Russian names appearing in the list of grand prizes for Class 30, viz, Messrs. Asaph Baranoff & Co., the Baranoff Manufacturing Company, and Zahar Morosoff, jr., call for special remark. Indeed, the articles shown by these three large mills, which employ seven or eight hundred hands near Moscow, were most remarkable; the printing was sharp, well-defined, and the harmony of color was beyond all praise. They sent some printed calicoes with Turkey red ground which were loud and striking, but absolutely irreproachable. But how is it, you ask, that Russia can turn out such splendid goods? It is simply because the Alsatian chemists, draftsmen, and foremen have preferred exile to remaining in Alsace under Prussian rule. Russian snows seemed less hard to bear than German hatred. These Russian goods do not however, affect the markets in the west of Europe, but appear to have a future marked out for them in the East, in Russia itself, which is a large market, as also in Asia, Siberia, and Persia.

Messrs. Rylands & Sons, of England; the Belgian Spinning Company, limited; Parmentier van Hoegaerden, of Belgium, Henri Kunz, of Switzerland; Parallada & Co., of Spain, and the España Industrial complete the list of grand prizes.

The absence of specimens of the manufactures of Tarare and of almost all those of St. Quentin from Class 30 was greatly regretted, and the same remark applies to Class 32, in which Roubaix and Tourcoing goods were conspicuous by their absence. This reminds me of an anecdote of Henry IV. It is said he wrote to his friend Crillon thus: "You may go and hang yourself, Crillon. We have gained the day at Argues, and you were not there." The present French Government might with equal justice reproach such towns as Roubaix, Tourcoing, Tarare, and St. Quentin for their want of faith in the enterprise. It may refer to the success of the Exhibition as a proof of what has been done without their help.

But in spite of these defaulters, Rouen, Roanne, and many independent manufacturers have proved, by their exhibits, that the cotton industry is flourishing in France; but while it is regrettable to find that certain centers of French industry did not take part in the Exhibition, the absence of specimens of the manufactures of certain foreign houses, which in their own country are in a prominent position, was most perceptible and unfortunate in many re-

spects. Who, for instance, as an American, can not help feeling sorry that such firms as W. & J. Sloane and others did not think proper, even after being appealed to so strongly, to send a few of those products which are due to their long and patriotic labors and which have been so immensely successful. Their magnificent carpets and pieces of furniture would, in the opinion of men most able to judge, have obtained the highest reward possible in their class. It would have been an additional subject for congratulation among Americans.

But coming back to our subject, namely, cotton, it would appear that weaving is not so new as many suppose. Some of the mummies in the Boulak museum, left to us by Mariette Bey, are wrapped in fine calico in a very good state of preservation. Of course I am aware that progress has been made in the process of manufacture. If you should ever have the good fortune to go through Gros Roman's or Hartmann & Sons' mills, compare the products of Sesostris' time and you will see the effects of the onward march since that age, besides which we must bear in mind that the pace has been doubled within the last quarter of a century. It is particularly pleasing to notice the improvements made in the cotton industry, on account of its being so necessary to the poorer classes, and this is no doubt why the consumption has so largely increased, such increase referring obviously to a greater degree of comfort among those to whom comforts of any kind are so rare. Common calicoes, madapollams, shirtings, printed calicoes, muslins, and a large number of other fabrics are popular throughout the world, both for durability and cheapness. I have had an opportunity of ascertaining for myself that cotton-weaving was practiced to a large extent by the ancients. After the close of the Exhibition I visited Egypt and Asia Minor, and brought back with me a quantity of specimens of woven tissue taken from the mummies of unknown queens who have been dead over four thousand years.

The English did not take a great part in the Exhibition, and we could not judge of their manufactures except by a few samples shown by a small number of agents. They supply the world with their products, but they did not understand that it was a fitting opportunity for showing how low a price they can reach. The only new things I remarked among their exhibits were some bed-covers with satin ground. They were really beautiful and were greatly admired by the ladies. I should think they are likely enough to meet with a good demand.

During the last few years a new textile fiber has been brought into the market, namely, ramie or China grass. The cost of decortication is, however, so much greater than that of cotton-picking that it is hardly likely to be a dangerous competitor against cotton. It appears that plantations have been started in Africa and elsewhere

on a large scale, so we shall be better able to judge when they have had time to show a return. As far as we can judge at present, for until now we can only speak of the quality, it is silky, fine, soft, and bright, and it takes the dye well. When used alone, it gives satisfactory results, while, when mixed with silk to make a low-priced article, it may be said also to be fairly successful; but at present it is dearer than cotton, and unless it can be placed in the market at a very low figure I really can not see what prospect there can be of its adoption.

I remarked with much pride the progress made by the United States in the cotton trade. I think the advance made in both weaving and printing justifies us in saying that such progress is sufficient to lay the foundations for a large and prosperous business in future. It is moreover a fact worthy of remark, and the Exhibition has made it still more apparent, that every country in the world is making headway in manufactures and trying to do without importing goods; in a few countries the various staple industries are still in their infancy, but as a rule they are prospering. So much the better; manufacturers will have to look abroad, it is true, to find outlets for their products, but they will find them very often in the most unlikely places. It is one of the effects of the march of intellect, so we can hardly complain; it only furnishes another illustration of what has been said over and over again, "the land wants men more than men want land."

But to return to cotton. Cotton yarns include single yarns for weaving, and double yarns, dyed or in the gray, for sewing cotton, lace, hosiery, and embroidery.

Cotton woven fabrics may be divided into three classes: (1) strong cloths, such as T cloths, fine and coarse calicoes, chintzes, madapolams, twills, glazed and embossed fabrics, and ticking; (2) light cloths, such as jaconets, nonsuches, gauzes, and plain and fancy muslins; (3) prints and chintzes.

The French cotton districts are in the Vosges and the east generally for articles of large demand and for calico printing. Normandy, Rouen, and Flers are noted for their hollandes, general Manchester goods, handkerchiefs, tickings, printed calicoes, and other goods requiring much material and little labor. In the department of the North, Lille, Roubaix, St. Quentin, and Amiens manufacture cotton for tulle, lace, curtains, velvets, and light fabrics. The Tarare and Roanne district is famous for various kinds of muslin, curtains, and the better qualities of colored striped cloth and checks.

The raw material still comes chiefly from America, notwithstanding the increased production in India, China, Egypt and Brazil. The lesson taught by the Exhibition seems to be that considerable improvements are being made everywhere in plant and machinery in order to reduce the cost of production and place goods within the

reach of the poorest classes, those upon whom fortune so seldom smiles. What a blessing cotton is after all.

CLASS 31.—*THREAD, AND FABRIC OF HEMP, FLAX, ETC.*

Class 31 contained a masterpiece of workmanship, a genuine work of art, magnificent, unique in fact, and worthy of being kept forever in a glass case. It was an immense tablecloth—no, tablecloth is not the word and hardly conveys a just appreciation of the article, which might be more fitly compared to a beautiful picture. It was sent by Messrs. J. Casse & Sons, Lille, who were awarded a grand prize. Was it worth 20,000 francs? 100,000 francs (I believe they were offered 100,000 francs for it)? I can not say, but I could never pass it without stopping to gaze in wonder at the harmony of color, worthy of a Rubens. It was 6 or 7 yards long by about 5 or 6 wide, and represented a party of noblemen with their ladies at luncheon, in costumes of Louis XIII, I think. I do not believe in the whole of this splendid piece of work there was a single blemish, not a float or a broken thread, nor was a single effect lost in the whole work. Messrs. Casse are adepts in these surprises; this is by no means the first they have turned out. The Rouen Museum contains two remarkable pictures in linen, which were shown in the Exhibition of 1878.

The manufacture is very varied and of a high class, from the ordinary everyday run of goods, such as common napkins, to more expensive open-worked ones with fringes. Messrs. Casse also make gimp, and flax and jute velvets, with silk and gold weft. They started some fifty years ago, and have their mills at Fives, Lille, where they employ over two thousand hands. They make their own looms, and are most certainly one of the largest and most respectable firms in France.

We have also to speak in terms of high praise of the articles shown by the “Comptoir de l’Industrie Liniere,” which perhaps turns out more linen than any other firm in France.

Messrs. Saint Brothers (established 1798), are manufacturers of sacking, coarse linen, upholstery stuffs in jute, cables, and hempen carding-cloths in enormous quantities. It is the largest jute mill in Europe. It furnished the following curious statistics to the jury of social economy concerning its seven mills: 6,800 operatives, requiring daily 60 tons of coal to produce 6,300 horse-power, and using 63 tons of yarn. These combined forces produce daily 57 tons of yarn, 15 tons of cordage, cables, etc., 135,000 yards of cloth, 48,000 sacks, and 3,600 cart sheets. Is there another mill in the world producing such enormous quantities of similar goods? It is wonderful where they all go to. What a marvelous thing human ingenuity is, and how strange are the laws of supply and demand.

Messrs. Carmichael Brothers & Co. (established 1845), who intro-

duced the jute industry into France, had also a fine exhibit of jute fabrics. They do a very large export trade now in sugar and coffee sacks, which are shipped chiefly to the colonies.

We must not omit to mention Mr. Cauvin-Yvose's interesting exhibit. He manufactures waterproof cart-sheets, and is a large army contractor. He also supplies the various railway companies, and made all the covers for the awnings in the Exhibition grounds.

But independently of these great flax and jute factories, there were a vast number of things of interest. France can not compete against Belfast on account of the climate, which enables the Irish to produce cheap light linens of snowy whiteness ; but the French can compete against the world in the manufacture of plain, stout linen, in which they seem to have gained the ground they had lost.

The French are more at home in fancy embroidered or printed goods ; their ingenuity seems to be boundless. They make handkerchiefs, bed covers, eider down quilts, printed or open-worked pillow-slips, which are absolutely perfect. Simonnot, Godard & Co. showed a bed cover and some new printed handkerchiefs made of lawn, which were absolutely incomparable. I do not think the English have produced anything to compare with them. Mr. Simonnot Godard was on the jury, so did not compete for prizes.

One of the gold medals of Class 31 was awarded for the French manufacture of China grass above referred to. There were some splendid things shown in China grass ; time alone will show whether it can be made to pay.

The French had formerly to compete with Germany and Belgium in table linen, but they are now supreme in foreign markets. Their designs are better and their goods better finished.

Courtrai, in Belgium, is still noted for its fine, plain, and striped linen. Flanders, and Courtrai in particular, maintains its old renown. The same thing may be said of France ; Lille, Cambrai, Chalet, Valenciennes, Amiens, etc., have world-wide reputations. The hemp, flax, and jute trades have greatly increased during the past few years, so that it is not surprising if a number of novelties in fancy fabrics are brought out each year. Linen can be made so fine, so soft, and so white, and it is such a strong and durable fabric, that it is easy to explain why it meets with popular favor. It is manufactured in a superior manner now, the factories are spacious and healthy, and contain all the latest improvements in machinery. It seems to be the motto everywhere now to improve the machinery, and study the health and comfort of the operatives. During the late commercial crisis, when the French felt the keen competition of the Germans and the English in those very markets which they had held the longest, when the consumption fell off to the extent of a couple of hundred millions, they set to work to discover the cause, and found they must improve their plant and get out of the old

grooves. It was a long time before the linen industries joined the movement, but they have at last seen the importance of making some change, and the results are already apparent.

Belfast competed keenly with France in the American markets formerly. There may perhaps be a change in that respect; time alone will prove. In any case the French have taste in their favor, and that is an important item.

CLASS 32.—THREADS AND FABRICS OF COMBED WOOL—THREADS AND FABRICS OF CARDED WOOL.

Combed and carded woolen fabrics used to be quite distinct classes of goods, but now in fancy stuffs they are much combined and mixed with cotton or silk, according to the effect to be produced, or according to the season or fashion. It is in such like products that the curious effects of competition are shown most clearly. Manufacturers imbued with the same idea proceed in different ways to arrive at about the same result, and the consequence is at times very singular. For whilst in the north they mix as much silk as possible with their wool, in the Rhone district they put as much wool as they can in their silk, the consequence being that more silk is consumed at Roubaix than at Lyons.

Class 32, which contained all kinds of woolen fabrics and unions, was certainly one of those in which the art of showing and setting off goods was carried to the greatest perfection, the greatest care having at the same time been taken of those articles which were exposed to the air. So much importance is, in fact, attached to window dressing in Paris, that good window men command good salaries. I do not know what was paid for dressing the show-cases, which remained so fresh and pretty for six months, but I say this: that those who arranged them deserved their money.

Class 32 presented a most magnificent spectacle. It was a continual round of agreeable surprises. The large French centers of industry sent the masterpieces of their work, and as we looked upon them we seemed to hear the busy hum of looms, shuttles, straps, and pulleys. Thousands of workpeople going to and fro came before our mind's eye, toiling in the steamy rooms, and keeping time with the restless jennies. Thousands of pieces are turned out daily from these looms, which never cease working.

Roubaix and Tourcoing, which only took a slight part in the Exhibition, and Rheims, Elbeuf, Lisieux, Louviers, le Cateau, Sedan, Fourmies, and a score of other towns, had sent their very choicest productions and maintained the incontestable superiority of French manufacture. It is now admitted on all hands, even by France's rivals, that she holds the front rank in combed wool fabrics, merinos, cashmeres, etc., and on novelties and tweeds.

Twelve grand prizes and over sixty gold medals were awarded in

Class 32, and this was not too many to acknowledge the merits of all the exhibitors.

Messrs. Bellest & Co., of Elbeuf, sent some splendid specimens of rich cloths. Messrs. Breton & Son, of Louviers, had some admirable novelties; the Sedan goods were quite up to the mark. Louviers and Elbeuf had gone down a great deal; but they have come to the front again now.

The group of Viennese exhibitors were awarded a grand prize for their printed cloths, which used to be made only in Germany. They now supply our market with printed cloths at 3 to 4 francs a metre, which enables ready-made clothiers to turn out suits at a very low figure. Elbeuf now produces light cloths for ladies' wear, which used also to come from Germany. This has caused quite a revolution in low-priced articles, for England and Germany used to flood the French markets with a lot of perfect rubbish. The new Viennese goods come as low and are of much better quality.

Amongst the grand prizes awarded special mention should be made of that given to Messrs. Grandjean & Co., of Rheims, manufacturers of very excellent light woolen stuffs, cashmeres, merinos, who showed some beautiful fabrics with silk warp and wool weft.

Messrs. Belin & Co., of Fourmies, were awarded a gold medal for their low-priced dress materials—75 centimes or 90 centimes a metre, if I remember rightly. They were made in various designs, checks, etc., and were very pretty and remarkably good value.

Messrs. Noirot Janson, of Rheims, obtained a gold medal for keeping their beautiful flannels for princess robes up to the mark. Reyrel & Co. showed a very fine selection of novelties in cloths of rare merit. Messrs. Boussus, of Fourmies, Boussuat & Gaudet, Duche, Michel Bureau for their novelties, Gamounet-Dehollande for his china satins, all received gold medals, as also Messrs. Michau & Co., who are manufacturers of cashmeres and fancy cloths.

A silver medal was awarded to Messrs. Lesser & Garnier, of Bohain, for a novelty which they showed, viz, imitations of fur, plush, and astrakhan.

We noted among the articles sent by M. Breant, a member of the jury, some cashmere shawls. They were noticeable on account of their being put in the market at the price of cashmere shawls, whilst being excellent imitations of Indian shawls. We were struck with the blending of the tints, the originality of the designs, and with their general resemblance to the real article. The idea is a good one, and may help to revive this trade, which is one the French excel in. M. Breant also showed some very fine specimens of new shawls for opera cloaks, and Algerian shawls in woolen and silk fabrics interwoven with wire.

Amongst the grand prizes we notice the name of Messrs. Eabourier, Bisson & Co. They received this high reward for their rich woolen

stuffs, cashmeres, vicunas, cloths of the Witney kind, and their woolen dresses in velvets and plain and worked material. In fancies they had a good show in gauzes, barege, veilings, crepe, grenadine, embroidered muslins, and gauzes interwoven with gold and silver for ball dresses.

The jury of Class 32 also awarded a number of prizes to Mexico, Portugal, Chili, Brazil, the Argentine Republic, and Spain for their woolen fabrics. They were specimens of industries just springing up in those countries, but showed much talent and originality, at the same time proving the progress which is being made.

I should like to say much more about the beautiful goods shown in this Class 32, but our ladies will soon be able to judge for themselves; the American stores have bought largely, and in the spring I suppose they will show what they have selected, so that American ladies may have dresses coming direct from the Paris Exposition. The astonishing progress made by French dyers and finishers calls for special remark. What delicate shades they produce; and how well they can set off a fabric by their harmony of color!

CLASS 33.—*SILKS AND SILK FABRICS.*

The silk department was organized as a whole by the Lyons Chamber of Commerce, and it was a treat to see it; everything was arranged with such incomparable taste. Taking it altogether, I am sure its like has never been placed before the public. The silk industry is one which has existed so long only for the rich, that it was a long time before manufacturers could see that some change was inevitable if they wished to keep the trade from dying out. Many difficulties were in the way of the radical changes necessary to bring their products within the reach of the masses. Everything appeared to be against them, even the nature of its production, the manners and customs of the Lyonnese, and they held out a long time against any change. This is why the silk trade has found its way into the various departments of that part of France, even to the Basses Pyrenees, where six hundred looms are now at work.

There were goods of surpassing beauty in the Lyons exhibits, but there were also specimens of lower-priced goods, giving abundant proof that the 20,000 steam looms in the Lyons district can compete successfully with the 3,810 at work at Krefeld, and the 4,122 at Zurich. It is therefore quite a mistake, though it is one which finds credence almost everywhere, that French manufacturers have not had the good sense to lay themselves out for producing goods for the masses. They moreover make a great variety of unions, using wool and cotton together to a large extent. They are now using immense quantities of the raw materials; it was in fact the French who first began to dye silk goods in the piece, and they are being

copied in their improvements in silk spinning by Spain, China, the Levant, India, and Japan.

While it may not perhaps be out of place here to say a word about the technical and professional schools (the weaving and dyeing trades both have them, besides which art schools and friendly societies have largely increased in number lately in the Lyons district), it would take too long, though I can not but hope the eminent Americans, who take an interest in such work, may inquire into the system upon which these schools and societies are established. The ideas of their founders seem rather Utopian, but from what I have been able to gather, they are doing much to improve and raise the social status of the working classes.

In the town-hall yard at Lyons, there is an inscription 300 years old to the effect that the silk industry is by tradition and the spirit of progress like an old world in a new one, or a new world in an old one, and that gives a tolerably good idea of this ancient and glorious industry; its distinguishing feature is that it clings to old associations and its memorable past history, mistrusting the unknown, and looking steadily forward into the future. A volume might be written on this interesting trade which does so much honor to human ingenuity. Silk is such a beautiful material that it is always popular, and when man has brought his skill to bear upon it, he makes it into a valuable and lasting piece of merchandise.

The recent struggles in this trade were both curious and instructive. The disputes were between the country workpeople and the town hands, at the head of whom were the overlookers. Now, as the manufacturers could not establish mills on the new plans, by which alone they could hope to compete with the Germans and Swiss, they had to start them in various departments at some distance away, as far even as that part of France near the coast of the Bay of Biscay and contiguous to Spain. In these mills, in which all the latest improvements are made use of, all is done by machinery; it seemed to them the only solution to get away from old associations and operatives with life-long prejudices. Lyons has always had the monopoly of first-class goods; it is the largest center of silk industry in the world; it is the cradle and the school of the silk trade. There are more hand-loomes there than elsewhere, and there are many things in the trade which are kept as family secrets and handed down from father to son. Silk goods worth 500 francs a yard can not but be a marvel, a masterpiece of workmanship, and such goods can not be made elsewhere than in Lyons; the Lyons weaver, the descendant of Jacquart, alone can produce them. They were shown at the Champ de Mars side by side with those magnificent flowered ribbons, made at St. Etienne, which so fascinated the lady visitors.

Class 33 is the one which obtained the largest number of grand prizes. It gained thirty-one, of which twenty-six went to French manufacturers, three to the Swiss, one to the Russians, and one to the Japanese. Many gold medals were awarded to French, English, Swiss, Japanese, Spanish, Russian, Belgian, Italian, and other exhibitors; as far as I know America did not send any silk goods.

I have so far only referred to dress materials, but the upholstery stuffs shown were no less rich and interesting. Messrs. Bardon, Ritton & Mayen, Berard & Ferrand, the grandsons of C. J. Bonnet, Bouvard, Brosset, Brunet Le Comte, Durand Brothers, Gourd & Co., Poncet, and Tresca Brothers, who were each awarded grand prizes, are well-known firms making very superior goods, such as plain and worked silks, shot silks, velvets, printed silks, satins, taffetas, crape, etc., and others too numerous to mention.

Messrs. Emery Brothers, Henry, Piotet, and others sent some plain and fancy upholstery stuff, church ornaments, carriage hangings, gold and silver braid and trimmings, which obtained grand prizes also.

If any importance could be attached to statistics, it would be worth while to quote figures in the case of such an interesting trade. We shall nevertheless give a few extracts from the annual reports published by the Silk Workers' Trades Union.

It is certain that silk was imported largely, especially before the expiration of the treaty of commerce with Italy; Marseilles was the market for the cocoons, raw silk, and silk waste coming from the East. A large export trade is done with all countries. And here let me condemn the system adopted by certain unscrupulous manufacturers of putting the word "Lyons" in gold letters at the head of each piece, and some fictitious name of a manufacturer to convey the impression that they are French goods. Such practices deserve the contempt of all fair traders, the more so as they are invariably affixed to goods of inferior quality; again, as the names are purely imaginary, it is quite impossible for French manufacturers to deny their authenticity or vindicate their honor. As Shakspeare says:

He that filches from me my good name
Robs me of that which not enriches him,
And makes me poor indeed.

It is not only Lyons which has suffered by these fraudulent practices; as fast as any one makes himself a reputation he is pirated, but "good wine needs no bush" and quality generally speaks for itself. Now, if there is one trade more than another which relies entirely upon excellence of material and workmanship it is the silk trade. Silk is the finest textile. It possesses every quality but one, and that is cheapness, and even by means of combinations with other materials it can be placed within the reach of all.

Some twenty years ago the manufacture of low-priced silks mixed with cotton fell off considerably, although it had been started at Lyons at the beginning of this century. At that time the total consumption amounted barely to a few million francs. It has now increased in enormous proportions, thanks to the recent improvements in the French machinery, dyeing in the piece, etc.; in fact in the year 1888 the production amounted to 147 millions, or two-fifths of the total amount produced.

The following figures speak for themselves: in 1879 the production of black and colored dress silks stood at 90 millions but had fallen in 1888 to $28\frac{1}{2}$ millions; pure worked silks went down in the same period from 30 to 17 millions, whilst black and colored satins fell from 56 to 15 millions.

But these losses have been largely made up by the increased consumption of new goods; for instance, armures rose from 2 millions in 1879 to 50 in 1888; satins with cotton woof from 24 to 38 millions, armures with wool woof from 2 to $8\frac{1}{2}$ millions.

The following curious and instructive table shows the amount of silk brought to the Lyons market in the year 1888:

	Kilos.
French silks.....	656,610
Silks imported from—	
Spain.....	53,489
Piedmont.....	196,314
Italy.....	893,549
Brousse [Turkey].....	129,225
Syria	195,234
Bengal	79,726
China	890,253
Canton	821,420
Japan	1,048,374
Tussah silk	163,822
From various sources.....	55,504
Total	5,183,520

The above figures do not include the Asiatic silks sold by the Lyons shipping houses to Swiss, German, Austrian, Russian, and American firms, so that we may estimate at 6 millions in round numbers, representing 300 million francs in money, the quantity of silk from all sources negotiated in the Lyons market in the year 1888. One-third of the silk produced in Europe, or coming from the East, is used in the Lyons district. I think Lyons may be proud of the position it occupies as shown by these figures, which are worthy of note in municipal and industrial records. The Exhibition at the Champ de Mars proved beyond doubt that Lyons is in full prosperity, and that for two reasons. The first is the extreme versatility of production; silk fabrics ranging from 50 centimes to 500 francs a yard, and including every imaginable sort of pure and mixed silk

fabrics; and the second is that certain kinds of fancy worked silks peculiar to Lyons have always stood high in public favor; the mills of Croix Rousse especially have been much brisker lately. It must be admitted that it stands unparalleled by any foreign industry, and I am fully convinced that manufacturers will by their talent and their energy always keep up with the times and maintain their position in the world.

This was evident to the most indifferent visitors to the Exhibition; no one, I am sure, could help being struck with admiration. It is said that the annual turn-over of the Lyonnese may be taken at 400 million francs, which will give some idea of the importance of this great industry.

CLASS 34.—LACES, NET, EMBROIDERY AND TRIMMINGS.

Class 34 comprised a group of new, varied, and important branches of industry, very different in character. The exhibits contained the work of thousands of women. These branches of industry are essentially feminine—only fairy fingers can succeed here. It is certainly in embroidery that women have always shown their taste, their patience, and their art in the most striking manner, from the half-savage African women to the refined Parisian ladies. An African explorer has even said that in certain central tribes the young negresses embroidered their own skin just as the men tattoo themselves. A specimen of this human embroidery would have created a sensation in the Exhibition. Certain it is that woman confined to her home, be it hut or house, needs to utilize her long leisure hours, and eagerly seizes upon any occupation that will employ her imagination and her delicate fingers. That is why every country sent embroidery of one kind or another. It is true that in Eastern countries there are also many men embroiderers, but nevertheless it is, I think, always and everywhere to woman that is due the credit of the progress made in this art, in so far, of course, as the handiwork is concerned.

There were very curious specimens of embroidery from all the tropical countries; Morocco leather boots embroidered in gold and silver; leather saddles enriched with gorgeous needle-work; presidential chairs with coats of arms and emblems embroidered in high relief with abundance of fine gold. Richness of effect seemed to be aimed at rather than grace, but here and there the strange effect produced was captivating. So, in the list of prizes we find a large number awarded to tropical countries. Asia and Africa are particularly conspicuous. Very different is the nature of Parisian embroidery. Here we have the work of masters in the art, of painters in oil, water colors, and pastel. Their graceful and scientific designs, their harmonious coloring, their soft tone—in a word, the finished perfection of their work certainly made one regret that these panels, scarfs, or

flounces were not intended to be framed and kept as works of art, instead of being sacrificed to the dust of the street, the sun's rays, and the cold winter ball nights.

In the show cases of Class 36 we found how these magnificent embroideries are used by the great Parisian dressmakers. They know how to make the best of them, and by applying them upon fine stuffs of delicate hues they succeed in producing tones of extraordinary softness; nothing is harsh, coarse, or ordinary; the garment is like a fairy covering, so tender, harmonious, charming, and unobtrusive is it. I shall have more to say upon this subject further on. Beautiful was the embroidery upon the stoles and chasubles, with their flowers, Agnus Dei, their rich ornaments, their large crosses, intended literally to cover the shoulders of the priest as he officiates at the altar.

The Roman Catholic church service by its pomp encourages art. Bronze goods, stained glass windows, sculpture, and painting are man's part in the decoration of the churches, whilst woman brings something bearing more clearly the stamp of her pious nature, viz, embroidery and lace. In the first place, rich ladies make the most incomparable tapestry in the retirement of the castle, and, while their liege lords go to war in foreign lands, they remain and, surrounded by their women, produce wonderful lace work for the altar of the church. The secrets of this work of faith and patience are handed down from mother to daughter, and spread through the neighboring hamlets, there to be preserved for centuries until art becomes industrial and is popularized by the later improvements.

The exhibit of Mr. Noirot Biais, one of the jury, contained some rich and interesting specimens of church embroidery. some of them being very costly and in fine gold, such as only well-endowed churches can afford, whilst others were more ordinary for less wealthy communities. The exhibit did honor both to Lyons and Paris.

In the show cases of Messrs. Idoux (who were awarded a well-deserved grand prize), Reichenbach, Rocheron, Treves (who all received gold medals), Lamperiere, Pouteau, Fichet & Co. (silver medals), and other excellent manufacturers, we find the splendid gold lace, the scarfs, ornaments, tulles, or woolen or silk stuffs in such great favor amongst American ladies of taste, and which our large dressmaking houses in New York and Boston have done so much to popularize this season. There were long train dresses embroidered in gold, others in silk or metal, of the most gorgeous kind. They were certainly very costly, and, when imported into America, the duties and other charges make them objects of great value; but I must confess that despite their apparent costliness the demand for them is easily accounted for—they are so extremely beautiful.

The army, the government, the various universities, the generals, prefects, and learned men also require gold and silver lace, and, just

as in savage countries, the highest rank is indicated by the greatest profusion of embroidery. By this means regular work is provided for large numbers of women, who are, as a rule, well remunerated; but it is when produced by machinery that embroidery becomes a really large and important branch of industry. It can be put in the market at a low figure, and so finds sale in all the classes of the social scale. Switzerland and France both have large mills for the manufacture of embroidery, and they vie with each other in the taste and beauty of their productions. The distinction between the two classes of embroidery—hand and machine made—is not yet clearly defined. There is still much confusion made; but in a short time hand-made embroidery, being especially applied to the bust, the neck, head-dresses, and skirts, will leave the trimmings and those parts of the dress which are less exposed to the machine-made work. The distinction will then be complete, and each branch will keep its own ground without encroaching upon that of its rival.

Switzerland deservedly obtained for its “*Directoire commercial de St. Gall*” and for some other famous manufactures a grand prize and several gold medals, which will help to maintain their reputation.

Before leaving the embroidery department, let us stop a moment before the goods sent by Mr. Clair-Leproust, who obtained by the Bronnaz machine some pretty effects applied to light bamboo furniture covered with colored plush. It was a good application of useful embroidery. It took well with the public, and, in fact, has sold well for some time past. It constitutes in itself a novel and important branch of trade, and has taken a front rank amongst fancy furniture. Mr. Crouvezier was on the jury and, therefore, did not compete; but his exhibit contained some masterpieces in white hand-worked embroidery. They were made in the department of the Vosges, and these carefully-worked sheets, handkerchiefs, toilet-covers, etc., in rich and graceful designs, did the greatest credit to this manufacturer, who, moreover, has a wide and well-deserved reputation. I can not give more than a passing word to the handkerchiefs, embroidered in white or colors, which are so largely exported from France to the United States, but shall refer to them again in Class 35.

Among the grand prizes of the class now under consideration I find the name of Mr. Langlois, one of the best of Parisian trimmingsmen, whose exhibit was close to that of Mr. Dieutegard, another great Parisian manufacturer, and also on the jury. Both these gentlemen, as well as their fellow-manufacturers, exhibited some splendid specimens of gold and silver hand-made lace. With regard to the more ordinary articles they did not think proper to show them. Was it because they were not sufficiently interesting, or because they did not show notable evidence of progress? I shall not venture to

say. Perhaps it was because they were afraid of being copied and thus losing the fruit of their labors. There are several centers of the gold and silver lace trade in France. Lyons, for instance, is renowned for its lace and facings for uniforms. St. Etienne is noted for novelties. Nimes and St. Chamont for trimmings, twist, lace, gimp, fringe, etc.; but Paris is the great center of this trade, and for the very good reason that the various branches of industry which supply the demands of fashion can not be separated; they must help one another, for they only constitute fashion by virtue of the special force which their coexistence in the same artistic and fashionable center gives them. All the various textile materials are employed in this manufacture, but chiefly wool, silk, cotton, gold, silver, and straw. The work is done with the needle or on Jacquard and other looms. The finer kinds are made in small workshops, the ordinary run of lower-priced goods in large mills and by steam power. Embroidery is of course mostly made by women and girls, and the wages paid vary considerably, according to the skill of the operative.

Owing to the difference in the price of labor, Saxony competes keenly with France in foreign markets; but where superior, rather than low-priced, goods are in demand France has the upper hand. Her constant effort is to produce novelties. The experiments in bringing them out are often very expensive; but this is compensated when, as is often the case, an article is produced which has run for several seasons.

What I have said of trimmings for both ladies and gentlemen's dress refers also to those used in furniture making, which is also a prosperous and progressive trade, and obtained a gold medal, awarded to Messrs. Weber & Son, whose exhibit was a most remarkable one. The manufacturers in this class have evidently been unwilling to show their best goods; otherwise we should have had a splendid show, for their resources are immense, and their productions in decorative art rich in effect and of rare beauty. We obtained some idea of this, however, in the furniture and tapestry classes, in which France maintained its high rank.

We now come to a very fine branch of industry, viz, the lace trade. I have not by me the now classic work on this subject by Mr. Lefébure, the official reporter of Class 34, which gives a full account of the history of lace; but there is no doubt it was practiced by the ancients of all classes almost as a religious work. The machine of former times was a small portable frame placed on the knees, and it has remained unchanged through all these centuries, being handed down from one generation to another intact. The worker goes on very slowly, seeing scarcely any result of her day's work, still moving with sure and vigilant steps in the intricate labyrinth. She works in her humble cottage for a modest remuneration; her hus-

band is at work in the fields, and her baby asleep in the cradle; the dog, her only protector during her long days, lies by her side and pricks up his ears at the slightest sound. Betimes the woman softly hums some national air, the memory of which is still fresh, although learned perhaps in her mother's lap. Well, ladies, this is how the lace you so much admire is made. Its delicate threads may well have something simple, yet mysterious and legendary, about them, and remind us of olden times and far-off lands.

English point lace, Honiton lace, and French point lace made at Alençon, Chantilly, Bayeux, Caen, and other places, are, I am sure, well known to ladies everywhere, for what lady has not admired their beauty as well as their lasting properties; what lady has not coveted some beautiful trousseau adorned with them? The specimens sent by Mr. Lefébure and those of other firms, who were awarded grand prizes, such as George Martin, formerly Verdé Delisle, the Compagnie des Indes, Robert Brothers, of Courseulles, and several Belgian makers, such as Messrs. Bergeran, Jules Lava, Dansart and others, were real wonders both in design and execution. The ladies crowded round these exhibits, and could hardly make up their minds to leave them. Lace, as well as embroidery, has had to submit to the profane influence of improved machinery in order to come within reach of the masses, for real lace, and the various kinds of point lace made at Alençon, Honiton, Venice, Bayeux, Valenciennes, or Bruges, are all so costly that the majority of women can not afford them. The curious and beautiful imitations, for instance, of the lace to be seen in the Cluny Museum, as also the Puy guipures made by the slender fingers of the Auvergne women, can never get into the hands of the women of the people; so that no sooner had the English invented the loom for making tulle than the French applied the Jacquard machine to it. Not that imitation lace can ever have the relief, the boldness, or the purity of the real article any more than a chromo can express the power or depth of color of a real picture, still very fair goods have been produced at a figure which placed them within the reach of all, and that is a great boon. Calais, St. Pierre les Calais, and Nottingham furnish the largest quantities of imitation lace. Messrs. Daveniere and Robert West, who have given great scope to their trade, were awarded a grand prize; several other firms, among whom I may mention Lecomte & Co. and Lepeltier, obtained well deserved gold and silver medals. Belgium holds the first place in the awards, as it occupies a high position in the lace manufacture, which is one always in favor among Flemish women; it has, moreover, a world-wide reputation from time immemorial.

Mr. Warée deserves special remark; he was awarded a grand prize, which those best able to judge consider well merited. Mr. Warée's factory is situated in the Vosges; he makes curtains, coverlets, and a variety of tasty articles, which, by the by, are largely exported to

America. The artistic curtains, which adorn the windows of Fifth avenue, are all his make. He turns out coverlets which are real marvels of taste and workmanship; there was one in the middle of his show case which was a finished work of art in every respect.

Mr. Neveu (grand prize) sent some matchless trimmings for carriages and railway cars. Another interesting specialty, represented by two firms, Mr. Blazy, on the jury, and Mr. Poiret, who obtained a gold medal, was that of tapestry on canvas. The canvas has a design printed upon it, a small part of which is embroidered in wool and serves as a pattern for the rest. Ladies buy them with the quantity of wool necessary to complete the work thus started. This kind of article has been largely developed by these two firms, and has become an important branch of trade; it finds work for a large number of women in the provinces, and the work is light and agreeable, requiring only a limited amount of taste and patience.

CLASS 35.—ARTICLES OF HOSIERY AND UNDERCLOTHING.—ACCESSORIES OF WEARING APPAREL.

Class 35 was certainly one of the best arranged in the Exhibition. It was well lighted, well planned, with seats everywhere for the comfort of visitors. The show cases were of the best construction, with large glass fronts showing up every article. The general arrangement does the greatest honor to the taste and ingenuity of Mr. Julian Hayem, the president of our jury, who, if I am not mistaken, planned the whole.

This class included the products of a large number of important and interesting industries, shirts, buttons, braces, gloves, fans, millinery, ties, umbrellas, parasols, corsets, embroidered and printed handkerchiefs, eyelets, sticks, etc. All these trades have a large turn over, both in the home and in the export trades. They are all well known in America, for these goods are shipped largely, and many of the names, to which I shall refer, have long been familiar to American importers.

The group of glove manufacturers of Grenoble, the center of the kid glove trade in France, and the well-known Chaumont firm, Messrs. Trefousse & Co., were each awarded a grand prize. Need we dwell upon facts well known to all? The glove industry is one of progress. The skins are dyed better than formerly, they are softer and finer, the gloves are better cut, and, above all, better sewn. Prices keep up generally, though they have fallen off in certain qualities, but the shipping trade is increasing.

Apart from the firms who were awarded grand prizes, I may mention the following, who obtained gold medals: Messrs. Bondat Brothers, the successors of the old and well known firm of Jouvin & Co., established in 1817 by Claude Jouvin, the inventor of the cut of glove which still bears his name; Messrs. Courvoisier, Bourgoïn & Co., and Francoz, jr., established a century ago and still being carried on by

the same family; and among the silver medals, Messrs. Boussard & Morisson, Buscarlet & Son, and Malo, jr.; all these firms are noted for making well-finished goods, and they do a large trade with America and English importers.

The two other grand prizes in this glass were awarded to two large Rouen firms, manufacturers of elastic web, Messrs. Riviere & Co., and their competitors, Messrs. Fromage & Co. These two very old firms have bought up all the small makers who had few looms, and so they remain alone in the field. They supply all those trades requiring web for such goods, as braces and garters, which also they make up themselves. Those famous braces known in the States as 26 gums are made by them, chiefly, for the last ten years, by Riviere & Co. The elastic web made at Rouen is in great demand for a variety of trades in France, besides which they are largely exported to the German and English markets. Large numbers of new designs are brought out each season, some worked in cotton, wool, or silk, every advantage being also taken of any improvement in machinery. These novelties stimulate the trade and make dealers renew their stocks. It should be borne in mind, however, that elastic web will not keep for a length of time; the threads of India rubber contained in them become vulcanized and eat away the fabric. Stocks should, therefore, be run off steadily, and new goods sometimes give an additional impetus to the trade.

Another well-known brace is the one known as the "Guyot suspender," made by Mr. Bailly; it was in its place at the Exhibition, for it is very carefully made and has an extensive sale not only in France but in America and England.

Messrs. Fayaud are also well and favorably known as brace makers; they obtained a gold medal. Other firms, among whom were Boulenger, Oulman, and Grandjean, received silver and bronze medals, long deserved.

An amusing illustration of the strangeness of class names is given with reference to braces. It was only in 1834 that they came into general use, and it appears that the first to use them were the men afterwards known as the "sans culottes," the "Breechless" men!

The button trade was certainly not well represented in its various branches, and in Class 35 it did not take a very prominent position; still we remarked Messrs. Bapterosses' exhibit, which obtained a gold medal, besides which the same firm showed in the ceramic class and were awarded a grand prize. It is they who make the agate buttons so well known in the States and throughout the world in fact. This porcelain button seems an insignificant thing, but looked at closer, and it will stand close examination, it is wonderful; what beautiful enamel, and how cheap! The agate button is one of the marvels of the age, and Mr. Bapterosses, who died a few years ago, was one of the greatest manufacturers I have ever

known. The Briare mills are models in their way, and their uninterrupted progress is only equaled by their success. Buttons, pearls, nail-heads, and other similar articles, beautifully bright, pretty, perfect in form and enamel, in infinite variety of sizes and colors, are from an industrial point of view nothing short of marvels. This trade is, however, not without competition; a Swiss manufacturer in particular makes similar goods, but no one sent any to the Exhibition.

Paris is the great center of the trade in metal, silk, corozo nut, wood, horn, and enamel buttons. It is in the department of the Oise that mother-of-pearl, bone, ivory, and some silk buttons are mostly made. They were formerly made almost entirely by hand, but machinery has made its way into this as into most other trades, and now the button, which is covered with silk by the needle, is perhaps the only one made by hand. We also remarked the boot buttons shown by Adt Brothers (silver medal), Anglade (tailors' buttons), and Bagriot, a firm noted for their metal stamped buttons; they make the gilt buttons for military and other uniforms. Messrs. Berthe, Wulveryck & Servas, in the department of the North, make ordinary everyday articles; Didron, an old house noted for its steel buttons, which are admirably made; Daguén, a maker of ordinary steel buttons; Lemaire Vallé, a maker of M. O. P. buttons; Leprince, novelties in metal buttons; Marchand, Bignon, Ammer & Co., established 1814 and well-known for their new styles of buttons of all kinds; Parent, another very old firm; Roulinot Brothers & Pradier—but I am afraid I am naming all the exhibitors, and perhaps this list may appear monotonous to those not in the trade. I shall therefore say no more, except that the button men are always studying to bring out something new and always afraid of being copied by their French and foreign competitors, who pirate considerably notwithstanding.

I may here make a remark which will be understood by all business men, and which applies to the whole Exhibition. In all the industries which rely upon novelties, and whose heads are continually trying to bring out some new thing, care was taken not to show the novelty upon which they are calculating for next season, viz, 1889-'90, for fear of having their creations pirated and losing the fruit of their labors. Such reserve will easily be understood; but it nevertheless deprived the Exhibition of a point of interest, for those in the trade, though, of course, the general public was not even aware of it.

The shirt trade, which exports largely, was represented by several large firms, who sent some beautifully finished specimens, of a good cut and no doubt fit. They are well established for making cotton shirts with linen collars and wristbands, as also for flannel shirts. It is here that the latest novelties in gentlemen's ties are brought out.

Their heads are men of taste, and each year they have a batch of new things in fabrics and made-up goods of very correct style.

Messrs. Sueur & Co. have also long been known as makers of first-class shirts. They have several works in the country and laundries in three departments. A simple, but skillful cut, careful sewing, and perfect finish have assured them a large export trade. They were among the first to whom we awarded gold medals. Some other firms, such as Colombier Bros., Schwob, Beaumont & Co., sent some well-made and highly-finished goods.

French hosiery was represented by the collective exhibition of the Syndical Chamber of the Hosiery of the Aube, whose principal center is at Troyes, and by several other manufacturers who sent goods on their own account, and of whom I shall now say a few words. Knitted work, which is a branch of hosiery, was shown by the group of Roanne manufacturers and by other separate firms.

The hosiery trade has had great difficulty lately in competing with English and German producers. Has it been successful? Well, yes, if we consider the quality, which is superior; but if we only take price into consideration, then for a few cheap lines we must say no. Manufacturers have availed themselves of all the recent improvements in machinery. They have even gone so far as to adopt improved manners of setting off their goods, and seeing that they can not impose their ideas upon clients, they now supply any size, color, or other detail asked for, and make for sale, not for show.

Three firms, well known in the States—Couturat & Co., Mauchauffé & Co., and Verdier & Schultze—obtained gold medals for the general excellence of the varied selection of goods shown. Several other good firms, such as Bouly-Lepage, of the Somme department, Tonnel, of Paris (gold medal), Bruley Brothers, Hirsch & Regley, Remy & Baulet, Quinquarlet, Rabanis, and Boileau (silver and bronze medals), all showed excellent goods.

Messrs. Bretonville and Mr. Dassol, of Ganges, and Sumène, in the Herault (south of France), are manufacturers of high-class silk goods. Several good firms of this section did not exhibit.

Messrs. Heilly-Hordé, of Villers-Bretoneux, who sent some shooting jackets, partly represented the Somme department, but many large firms did not exhibit.

The woolen knitted work, shawls, boots, children's frocks, skirts, and tippets, made at Roanne and shown independently of the Roanne collective exhibition, enabled us to judge of the excellent goods produced by such firms as Messrs. Ducreux, Margue Brothers, Oudin & Millet, Pauly-Robelin, and Saunier-Prudon.

I now come to an article which has been considered as peculiarly French, and that is the fan. Whether artistic and made a thing of beauty, or merely for sale, it is a French product. It is true that the cheaper article has been cut out lately by the Chinese and Jap-

anese goods, which have swamped the market, whilst the medium quality has been largely made in Austria (Vienna, for instance) and Italy. But for the better class of fans (those painted by artists) Paris still stands unrivaled. The very best artists in oil and water colors, the finest draftsmen in the country, place some of their choicest work on fans. The fan is often mounted in carved mother-of-pearl, in tortoise shell, in carved and gilded wood, which sets the painting off still more, besides which fine feathers and even precious stones are sometimes added. Fans are often princely presents. There were some beautiful ones shown. Mr. Duvelleroy obtained a gold medal for some, as also did Mr. Kees. It is an article which leaves great scope for fancy work; so we were not surprised to find many novelties in the Parisian and Viennese exhibits. There were many varied styles, and a good number of exhibitors obtained prizes, Messrs. Evette, Ahrweiler, Ettlinger, Creusy, Lepault & Deberghe, Levy, Rodien, Krakauer, Kreycy, Moser, and others.

Mr. Hugot, who was on the jury, sent some particularly interesting fans, which must have been greatly admired by American ladies. Mr. Hugot is a manufacturer who deals largely with our commission agents. He makes it a point to study the taste of American ladies, and he has been successful.

We have also to call the special attention of our lady readers to another exclusively Parisian article, and one which concerns them alone, and that is the corset. Much progress has been made in the manufacture of this article within the last few years. It is one of the most important articles of the lady's wardrobe, and one on which her grace and often her health largely depend. Badly made stays bind the waist and bring on a variety of diseases. They are a subject of annoyance, both to intelligent ladies and those who deal in them. If, on the other hand, they are well made, they impart grace to every movement; they support the body, giving it additional suppleness, thus preventing fatigue and illness, besides being a source of pleasure for the wearer. It is therefore important to have stays well, I may say scientifically, made. Many attempts have been made, many experiments tried, and if perfection is not yet attained, it is, at all events, certain that many evils have been remedied, and that the modern corset is no longer an instrument of torture. When made on the new lines it helps nature, and by no means obstructs the vital functions. Mr. Farcy, of the firm of Farcy & Oppenheim, was on the jury, which placed them out of the ranks of the competitors. They make those corsets which are marked "C. P. a la Sirene," and have been in the front rank of corset reformers. Not far from their exhibit we remarked the excellent stays sent from Bar le Duc (gold medal), a large manufacturing center in that trade. The following are the chief names: Chabaud, Fadon, Leprince, Salomon, Legrain, Pere, Lange-Porcherot, Stiegler, Ulrich-Vivien, and Willinger the three

latter of Bar le Duc, besides which there were several firms making special lines, viz, Josselin, Dacier, Jonatte, Prudhon, de Gruyter, Davoult, and others. One firm, Messrs. Pilte & Clapin, makes girls' and children's stays.

Two American firms, who make very excellent corsets, were rewarded by the jury. They were Messrs. Mayer, Strouse & Co., of New York (gold medal), and Messrs. Roth & Goldschmidt, also of New York (silver medal).

I am afraid I am wearying my readers by these long lists of names, and still I have so many things I should like to refer to in this Class 35. This corner of the Exhibition was like a little world, there were so many varieties of goods to examine. The foreman of the jury, Mr. Mortier, of the firm of Peron & Mortier, of Troyes, sent some remarkable specimens of hosiery. He will have a big volume to write if he wishes to give some account of the twelve or fifteen trades included in Class 35. It will not be a very easy task.

Class 35 also included sticks, umbrellas, parasols, their fittings and trimmings. The trade is carried on principally at Paris and Lyons. A gold medal was awarded to Mr. Meurgey, a very old firm, which is continually bringing out novelties. There were several other good firms who are always striving to combine lightness, strength, and grace in an umbrella or parasol, and that is rather a difficult problem to solve.

We awarded a silver medal to Messrs. Follmer, Clogg & Co., of New York, who had an excellent square case well filled with first-rate mounts and handles of various kinds. A well-known firm, Messrs. Lepetit-Charollet, and the large warehouses of the Gagne-Petit and the Bon Marché were awarded gold medals. Such articles as dressing-gowns, collars and cuffs, light petticoats, and other charming furbelows are admirably made up in France. With fine linen or cotton, some embroidery, trimmings, lace, and ribbons, they make a vast variety of light and elegant nothings, of which women are so fond for themselves or for their babies. Mr. Léon Dennery, one of the best known to American merchants, was awarded a silver medal for a choice selection of embroidered and printed handkerchiefs. It was a well-deserved medal, for Mr. Dennery has been well known in the States for the last twenty years as a maker of tasty and elegant goods.

Mr. Klotz, who was on the jury, had a fine show of men's ties, remarkable for their richness of color and correct taste. This is quite a Parisian trade. It was represented by several firms besides this maker, who, being on the jury, was out of competition. In fact, if we consider the class of collars and ties now selling, we must admit that this trade is making its way in France. A few of the best known firms are Messrs. Akar & Co., Bourgeois, Laborde, Tharel, Legée, Leprevost, Marix, and Meyer. The best English makers did

not exhibit, nor did the Germans, as I have said before, so that it was not possible to compare the goods made by the great industrial centers. I think, however, it is not too much to say that the French are still at the top of the tree for tasty goods of superior quality, besides which they mount their articles better, and have a style, of their own, of setting their goods off.

We can not pass from Class 35 without referring to Messrs. Neyret & Co., who sent some good specimens of jersey fabrics. When, ten or a dozen years ago, the jersey fabric first came out, opinion was much divided as to its merits. Many thought such a fine-ribbed material, so soft and so elegant, had a long run before it, while others gave it a couple of seasons at the outside. Messrs. Neyret & Co. were among those who had the greatest faith in the success of the novelty. They at once laid themselves out fully for producing it in large quantities. They put up looms for weaving it, and opened large workshops for making it up into garments. The success of the article has fully justified their spirit of enterprise, for the jersey, both as a fabric and as a garment, has stood the test of time and is likely enough to be in permanent favor. We saw it applied in other parts of the Exhibition, and especially in the ladies' garment department, in which several firms, among whom were Le Roy & Co., showed some rich and well-made garments in jersey material, with velvet facings or trimmed with lace and ribbons.

We awarded a number of prizes to foreign exhibitors, not only because France was under an obligation to her guests who had responded so heartily to her invitation and had done so much to make the Exhibition a success, but because we wished to give every encouragement possible to those industries which are springing up, and which will have been stimulated by the more perfect specimens sent by the old established firms. Greece, Japan, Roumania, and especially Servia, which alone had two hundred and forty exhibitors (to France's two hundred and eighty only), nearly a third of the entire number of exhibitors in this class—there were seven hundred and ninety-six in all—sent a quantity of articles made by women—millinery, hosiery, embroidery, and gloves. These goods showed that there was an eager desire on the part of makers to produce tasty articles. It was however at the same time apparent that their industry was still in embryo. We nevertheless took into account the fact that these people were making the most praiseworthy and patriotic efforts to make the best of the position in which they are placed, and so we gave them satisfaction as far as lay in our power.

CLASS 36.—WEARING APPAREL FOR BOTH SEXES.

If, when the various departments were being fitted up, there had been no serious dissensions amongst members of the committee of Class 36, there would most likely have been a better show of ladies'

garments. Those foreigners to whom the great French dressmaking firms are so well known—Worth, Pingat, Doucet, Rouff, Laferriere, Raudwitz, Honnet, Morhange, Dasuzeau, and others, the great firms for ladies' hats, such as Virot, Laure, and many others—were justly surprised at not seeing any of the remarkable creations of these houses in the clothing department. It was certainly most regrettable, that some little personal unpleasantness should have deprived us of the specimens which these great leaders of fashion might have supplied; for the general effect was not by any means as brilliant, as it might have been, for that very reason. We must not, however, on that account think less or speak slightly of those who did exhibit, for they at least did their best to maintain the high reputation of French manufacturers.

Those, who have never been present when a new fashion of dress has been made, have much to learn. It is an interesting sight only to be seen in Paris, for it is only there that those whose business it is to create fashions have at hand the various trades required in the making up of a lady's dress; silks, woolen stuffs, embroidery, lace, trimmings, velvets, flowers, jewelry, millinery, ribbons, buttons, clasps, and what not. All the choicest productions of a score of different industries, combining on one spot the labor of hundreds of factories, and of thousands of skilled work-people. The fashion-maker is there in the middle of this magnificent selection of goods; he chooses, compares, and tries, and the ideas come to his mind by the clash of colors, the bright sparkling of the gauze, and the charm of the embroidery. The beautiful dress, in the formation of which the contrast of materials has so much aided and which is to be the admired of all admirers in some grand drawing-room, takes form slowly under the anxious direction of this master of fashion. There it is at last, finished! It is a genuine work of art, full of grace and beauty, and the charms of the beauty, who is to wear it, will be increased and set off by its symmetrical folds.

There is less scope for variety in men's dress, and still tailors show no less talent in adorning the stronger sex. The materials shown by the great tailors were all that could be desired so far as richness and design were concerned, besides which there were several more or less successful attempts to bring out colored garments; there were red, maroon, and blue coats, waistcoats, and trowsers; some with flowers worked on the cloth, on light and bright grounds, all of which were risky things for men's garments.

With regard to the mysteries of the art of cutting, only the initiated ones can speak of them. Perhaps the distinguishing feature of this season's cut was a tendency to produce more manliness in the garment, and avoid any appearance of effeminacy. The shoulders were made square and the shape close fitting about the hips. Most people will admit that a man should be clothed so as to make his

strength evident, and show his muscles. I rather like such bold cutting, for I think a tailor's duty is to make men look more athletic and vigorous, and steer clear of any girlishness. Gilt buttons on a blue or red coat may be good enough for liveries, but for my part I prefer a plain and simple cut with dark materials. However that may be, there were garments for all ages and all tastes in the great tailors' show cases.

What showed more than anything else the progress made in the tailoring trade was the uniformity of cut among the low-priced articles of everyday sale, for as the drapers now produce those printed cloths which have been so much talked of, and which were previously imported from England and Germany, the ready-made tailors took advantage of them to make up some most astonishingly low lines, such, for instance, as trowsers at 6 francs and suits at 20. It was literally giving them away, and still they were not bad ; and a noteworthy feature was that the French cloths were of better quality than those imported from abroad ; the garments also were better made and more lasting.

Hats and boots and shoes were included in this class, which comprised no less than nine hundred exhibitors. Only five grand prizes were awarded ; three to France, one to England, and one to America. Christy & Co., the famous English hatters, obtained one, and the other, our countrymen, John B. Stetson & Co., the celebrated felt-hat makers, who brought out the hat which the Parisians have christened the " Buffalo Bill."

Like all the other industries of which we have spoken, hat and shoe making have made enormous progress. I find I am making the same remark a number of times, but I can not do otherwise, it is only justice.

Messrs. Fanien, Mossant, and Tirard, the three French grand prizes in boots and shoes and felt hats, do large export trades, and compete successfully against foreign makers under difficult circumstances.

The boot and shoe factories are now fitted up with machinery, embodying the latest improvements. There is the keenest competition between France, England, and Austria. I was rather surprised to find that the States were not represented in this branch as well as they were in hand work ; in the latter branch, Beneke Brothers' exhibit was greatly admired, and obtained a gold medal.

The English make a superior article for which they have large markets in their colonies, whose population exceeds 300 millions. They obtained a gold medal, awarded to Messrs. Manfield & Son, who opened a shop in the heart of Paris (Boulevard Montmartre) ; another was awarded to Mr. John Lobb, also a good maker.

Austria makes good shoes in styles similar to the French ; Messrs. Kompert Brothers, for instance, who were awarded a gold medal, compete with French makers in the export trade. Certain countries,

which formerly produced nothing, turn out very good boots and shoes now; for instance, Spain and the Balearic Islands, where there are two or three firms. Besides the above, Mr. Marexiano, of Montevideo, makes very fair imitations of French boots. It is the inevitable law of supply and demand. Industries are springing up everywhere, and every nation is trying to do without foreign productions. That is the fact, and we must make up our minds to it. "Time and tide wait for no man." In South America mills have been started and they are prospering, so that France must look out for fresh markets or else improve upon improvement, if she is to keep in front. She will strain every nerve, that is certain, for she will not settle down quietly to accept the loss of these her oldest consumers, especially as they are of the same Latin race, and bound to her by ties of friendship and "auld lang syne."

Perhaps it may not be out of place to say a word here about certain changes in style and manufacture. On the one hand, it is worthy of note that imitation leather is less used, its place being taken by cardboard, which answers better; and, on the other hand, we were glad to notice that more attention is being given to clog-making; clogs are excellent wear, especially for children, and those sent by Messrs. Ranciot and Schwartz showed progress and obtained rewards.

There were several manufacturers and connoisseurs on the jury, viz, Messrs. Appert, Touzet, and Galoyer, who know their trade well, and whilst anxious to acknowledge the merits of the firms who export most largely, they would not slight those who are noted for good workmanship in hand-made goods; they therefore rewarded many Paris and foreign firms, among whom I may mention Messrs. Coquillot, Jeandron-Ferry, Lobb, Bisch, and Pinet.

Mr. Mirtil Mayer (gold medal) and a few other Paris firms showed a variety of articles in feathers for hat and dress trimmings, which were also applicable to boas, collars, cuffs, etc. It is one of the most interesting of fancy trades. How sad to think of the number of small birds annually destroyed to furnish the vast quantities of feathers required in these trades. How many woods and valleys which they have enlivened with their song must now be silent and mournful from the absence of these poor creatures who have fallen victims to the beauty of their plumage! And this year you may see, not only one or two birds on a hat, but three, four, five, six!

Let them clear distant forests, prairies, tropical countries, or the sunny banks of the Ganges of the birds which make their homes there, but let them spare the little birds of our own country, for if the race is sacrificed we shall lose the farmers' friend. I hope, therefore, that the Parisian ladies' hatters will not empty the nests entirely. A French writer says in one of his works, "Do not put the woods in mourning."

And now a word about flowers. There were indeed some beauties, both for wear and for the house. Camille Marchais still makes improvements upon nature in the way of roses, so much so in fact that a bee tried one the other day, and Javey still makes begonias which out-begonia the begonia.

Paris has long had the monopoly of artificial flowers, and even now, in spite of the keenest competition, it still holds the palm and is likely to keep it if quality is any criterion. Our American ladies know these delicate and charming productions; some are most inimitable imitations of nature, whilst others are still more astonishing creations. The patient and artistic work-people who produce them can make anything, from the dewy lily to the blade of grass or friendly daisy. The materials for flower making are manufactured at Paris and Lyons; the fabrics are surely finer in texture than any rose leaf, nor can any butterfly's wing vie with them for lightness.

Fairy fingers dye, paint, and make up the flowers and leaves with such incredible dexterity that a hat trimmed with Paris flowers may go around the world and still, in spite of rain, wind, and snow, outshine the real article.

There is a new branch of artificial flower, viz, that of real corn, barley, etc., dyed in most shades and made up in sprays with grass flowers, thistles, or ferns, all of which are real, but prepared so as to keep for a great length of time. They look most delightful when placed in vases or bouquet holders, hung from the ceiling or on the walls. They are not expensive, and are so much like nature that we almost imagine we see upon them the distinct traces of the dusty field, the sun which brought them out, and even the morning dew. The chief apostle of this great change in the trade is Mr. Parent, who sent some really splendid specimens of his work.

I must now try to find room for a word or two about ladies' hats. The old saying still holds good that if you are out of fashion you are out of the world. If it were not so, I should have had my say against the singular shapes of hats in fashion this year. What queer hats (almost like French priests' wide-awakes) women do put on their heads now! How absurdly they project, what heaps of flowers and ribbons, and what massacres of birds! The wonder is that they can manage to look so charming under it all. How they do it the god of fashion alone knows. There were very few ladies' hats at the Exposition, but I detest the new shapes so much that I am glad to curtail this article as I should like to curtail those dreadful brims.

I must not close my remarks upon this class without referring to the liveries shown by Mr. Sutton and other firms who make a specialty of footmen's clothes. They were all very fine and stately; I am sure the fine big fellows who are to wear them will be set off to the best advantage in these tremendous coats; as they stand in

some lordly mansion they will only require javelins in their hands to make the illusion complete.

As we leave Class 36 we are still detained to bestow a passing glance upon some excellent dresses sent by our great dressmakers. A remarkable one was a Greek costume shown by Madam Margaine; others were draped robes, embroidered on crape, exhibited by Messrs. Pasquier, Pansard, Ulliac, Le Roy, etc.

Miss Linn-Faulkner's case of hats and Mrs. Loisel's exhibit of head dresses contained some curious articles of ladies' and gentlemen's clothing.

I do not care for the theatrical style so much cultivated by our great dressmakers in the models of dresses and costumes shown. Everybody has not to go on the stage, and correct taste tends more toward simplicity. A simple gracefulness is the characteristic feature of the work of a master, and I feel satisfied that many American ladies are of the same opinion.

CLASS 37.—JEWELRY AND PRECIOUS STONES.

This section was very popular, and rightly so. Not on account of the enormous quantity of gold and precious stones heaped up in such a small space, though that was perhaps one cause, but because of the talent shown in mounting these gems and so adding to their intrinsic value. What is most prized in a piece of jewelry is not the quantity of gold used; on the contrary, that is what tells against it in the eyes of a man of correct taste. What is observed is, to what extent the jeweler has taken advantage of the metal used, and what amount of grace and beauty he has imparted to the article, in order to give it that inexpressible charm, for which the object is more valued than for its weight.

"'Tis true, 'tis pity, and pity 'tis 'tis true," but the gentlemen, and particularly the ladies, since the fall in the value of precious stones, have shown a marked preference for gems over gold work. What ladies want now are quantities of precious stones to show the extent of their fortune, rather than artistic specimens of jewelry to prove their taste. I must, however, say that our American ladies begin to see the matter in its true light now; diamonds are already getting out of favor, and jewelry in the best sense of the word, that is, jewelry deriving its value from art and skilled workmanship, is being more eagerly sought after. And yet the Syndical Chamber of Jewelry has spared no effort to enlighten the public and to form artists worthy of their predecessors in the handicraft. It has done very much in that direction by publishing a literature specially intended to elevate the public taste, and set up art in opposition to mere wealth. It has opened schools and evening classes, where workingmen and apprentices may acquire taste and improve their minds, and it has always held up grace and charm as against an

excess of metal and gems. But, after all, the tendency in that direction has increased, the purchase of gems being looked upon as an investment of money, so that the jewelry trade, as a trade directly interested in cultivating the public taste and encouraging art workmanship, has suffered to a certain extent. France stands first in this industry, and leaves all her rivals far behind. England is a close competitor, though she can only approach France by the help of her French draftsmen and leading hands. Those firms, who employ Englishmen exclusively, turn out coarse, heavy, shapeless goods, having the very faintest relationship to art. Machinery has, moreover, been brought into operation and has revolutionized certain branches of the trade; as, for instance, the manufacture of chains, charms, plain bracelets, and stamped and pierced earrings.

But if art has lost ground, trade has gained abundantly, and France can compete successfully with Germany, especially since the introduction of the export stamp, which enables French jewelers to make jewels of any standard required by purchasers, the standard of 750 thousandths (18 carat) being, however, still retained in the home trade. Jewelry of the lower standards maintains its superiority over that made abroad as regards taste, elegance, and finish, these being the distinguishing features of French over foreign mounts. There are also a number of French diamond-cutting firms, whose work is equal to that of the Dutch houses; the Parisian lapidaries show great skill and the mounters much talent, so that success seems certain.

Parisian jewelers are closely bound together by a very proud and very rich corporation. Several firms date from the last century. Bapst, for instance, was established in 1725, and Marrat Brothers in 1810. They had a splendid and most artistic exhibit, which, however, did not enter into competition for prizes, Mr. E. Marrat being on the jury. Mr. Boucheron and Mr. Vever both had very remarkable exhibits of fine jewels, and were awarded the two grand prizes obtained in that branch.

Two other grand prizes were awarded, one to Messrs Savard & Son for their plated jewelry, and the other to Messrs. Topart & Ruteau for their excellent imitation of pearls. Tiffany & Co. obtained a gold medal, being in that respect placed by the jury on the same level as the best French jewelers, such as Fouquet, Rouvenat, Gross, Aucoc, Moche, etc. They have a world-wide reputation as gold and silver smiths. They had a most artistic exhibit in this class of goods in another section of the Exhibition; but we think proper, nevertheless, to mention it here.

This celebrated firm was remarkably successful in 1878, when Mr. Tiffany, who obtained one of the highest awards, was appointed Chevalier of the Legion of Honor. Their Paris branch is known to show masterpieces of high-class jewelry. Apart from the medals

awarded to them at the present Exhibition, the high honor, conferred by Government upon Mr. Tiffany in 1878, has now been conferred upon another member of the firm. All Americans will agree with me in congratulating Messrs. Tiffany & Co. on such brilliant and deserved success. It is an honor to them and to our country.

CLASS 38.—PORTABLE WEAPONS, HUNTING.

The Exhibition conveyed a very accurate idea of the small-arms trade as it is, for nothing that was shown was made specially for the Exhibition, many of the gun and sword makers having very slight confidence in the success of the undertaking. There was a very good show notwithstanding, and one in which the superiority of French goods was again manifested. It must, however, in justice be added that certain well-known English firms did not exhibit, and that Belgium, although well represented, had only a few exhibitors. Germany sent nothing; neither did Austria or Italy. There were a few Swiss and two or three Spanish exhibitors.

The United States showed great superiority over all other countries, even France, for machine-made goods. They make indeed for the million, and their arms being made entirely by machinery can be produced at prices which would be out of the question in Europe. As to this being desirable or not, opinion is divided, for it is alleged that such mechanical, almost automatical, production prevents progress in such work as is made by that thinking tool, man. As the workman bends over his vise, file in hand, or checkers a pistol butt or gunstock, he imparts to his work a certain perfection and individuality which can never be obtained by steam power; but however that may be, the jury highly appreciated the arms sent by the Winchester Repeating Arms Company (grand prize), Smith & Wesson, and Colt's Patent Fire Arms Company (gold medals); and no doubt Mr. Gastinne-Renette, the foreman of the jury, himself a good judge, being one of our best Paris gunmakers and the grandson of a gunmaker, will state that opinion officially in his report, and acknowledge the superiority of the United States for the wholesale manufacture of ordinary repeating arms.

In Europe the Government factories are the only ones in which the manufacture of arms is carried on extensively, so that the States are alone producers of low-priced articles. We have, therefore, been signally successful in this branch, and I am pleased to mention the fact.

Paris, which enjoys a marked superiority, London, Liege, and St. Etienne have each connections of regular customers for fowling pieces and rifles. Paris especially makes arms to order for each purchaser. Such articles are of more accurate and artistic workmanship than can be obtained elsewhere, and are easily recognizable as hand-made goods and made to order. During the last century there

was a gunsmith's technical school at Versailles. It made a specialty of those magnificent swords and muskets of honor which the first republic awarded to its soldiers and generals for bravery, and which are still to be seen in the various museums; but when the Legion of Honor was established, the cross was substituted for the sword of honor, to the great detriment of art and the small-arms trade. Then, again, the necessity of producing wholesale gave the final blow to those masterly pieces of workmanship now so seldom met with.

If we are to keep genuine master gunsmiths in the country, professional schools must be established where the old traditions of the craft—which are the glory of the French—may be taught and handed down. In the mean time the art seems to have taken refuge in one or two Parisian and English shops, where those, who know what a good arm is, are able to find it.

Class 38 did not show much that was absolutely novel, but it was noticeable on account of certain improvements on systems exhibited in 1878, and for a few changes made in the improved hammerless guns. The Belgian exhibitors showed some excellent arms; they are following closely on the heels of the English and French. Leopold Bernard, cannon founder, Eley Brothers, Richards & Co. (England), Fauré-Lepage and Gaucher-Bergeras, French firms, and Messrs. Heuse Lemoine and Pieper, of Belgium, obtained grand prizes.

La Société française des munitions (grand prizes), which has bought up Messrs. Gévelot & Gaupillat's, and other firms, has monopolized the manufacture of ammunition for pistols, revolvers, cannon, and mitrailleuses; it is a most important company now and makes good use of its monopoly. England exhibited some excellent cartridges, while those sent from the States were, on the contrary, not worthy of the firms who sent them.

The Government gunpowder mills still make improvements in their manufacture, besides, like many private firms, looking with ever-watchful eyes for any means of providing additional security for the work-people. In fowling pieces much progress was noticeable over the goods shown in 1878; the articles shown were well finished and well made all through, and compared favorably with the English exhibits.

Messrs. Lochet & Debertrand had an immense show case which was a source of great attraction for visitors; it contained the largest and most complete collection of dog collars ever seen. They showed an advance on anything produced so far, from the small velvet collar for King Charles' spaniels to those enormous ones made of calfskin, and bristling with steel spikes, for mastiffs, bull dogs, or Newfoundland dogs, including, of course, many varieties of hunting dogs. Manufacturers of these goods complain loudly of the fraudulent imitations of their creations by unscrupulous makers at Berlin,

who pirate their designs, but use inferior raw material in order to cut down prices.

The arms sent by oriental countries and submitted to the jury were only interesting from an ethnographical point of view; their origin made them curious, and their gorgeous appearance, inlaid all over, as they were, with silver and mother-of-pearl, brought up the price, but as practical weapons they were almost worthless.

CLASS 39.—ARTICLES FOR TRAVELING AND CAMP EQUIPAGE.

This is a section which should have been better filled. Traveling bids fair to be the coming amusement, and there is every likelihood that an eager desire to see foreign lands will take possession of future generations. Thanks to railways and fast steamers, traveling will soon be, comparatively speaking, easy and cheap. Voyages round the world will be organized by future Cooks, who will reduce the cost to a minimum, so that every young man and every new married couple will want to go on a trip. Exploring is in fashion now, and the number of explorers is daily increasing. I think Class 39 did not justify our anticipations. There was not a single new or practical trunk, one containing much but weighing little; nice, but substantial. Neither was there anything new in camping requisites. Jules Verne would not have found trunks to suit him, nor could de Brazza find an outfit or tents for his exploring parties. What is the cause of this dearth? If what is said is true, I pity future trunk-makers, for they will most assuredly be cut out by the stores. It is reported that certain makers sent nothing for fear of having some unpleasantness with the stores here, the latter having monopolized the entire retail trade of the city, from sugar and coal (shown in cut-glass stands) to diamond brooches. If that is true, it is extremely regrettable and is worthy of attention as a sign of the times.

Class 39, to which we are now referring, and Class 22 (paper hangings) were the only two of the 83 classes in the Exhibition in which the juries did not award grand prizes. There were, nevertheless, a few articles calling for notice in Class 39, so that we must not criticize too severely.

The most novel and the prettiest article, which is, by the by, the one in which the largest trade is done, is the waterproof garment. Mr. McIntosh, who invented the tremendous India rubber capes to protect people against London fogs, and which required a footman to carry them after a shower, must look down with pleasure on the modern article. The Roubaix houses are now making the most beautiful waterproof materials possible for the mind to conceive or the heart to desire. They are made of pure silk, silk and wool, or silk and cotton, according to price. There are stripes, checks, shots, plaids, etc., in every variety,

and each more lovely than the other. These soft light materials are made up in Paris into the most charming garments imaginable; some have sleeves and hoods, some have neither; some bind at the waist, others do not, but all bear the unmistakable Parisian stamp; and as it is in the Parisian nature to create and invent, whether in hats, boots, or jackets, a new waterproof garment is brought out almost daily. The strangest thing is that this cloak does not give a heavy appearance. On the contrary, it gives freedom and elegance to the ladies' dress. Perhaps the reader smiles, thinking this is an advertisement in its way. This is not, however, my intention, and I invite any dubious reader to judge for himself by examining the goods produced by such firms as Messrs. Fayaud, Guibal, Hutchinson, and Torrillon, who obtained gold medals.

The Boston India Rubber Shoe Company obtained a gold medal for their excellent India rubber shoes, as remarkable for perfect shape as for superior quality.

Mr. Thuau showed a very good camp bed, which gained the prize in a competition opened by the secretary of war. He also obtained a gold medal from the Exhibition. Mr. Quillons, who had a splendid exhibit of military and explorers' tents, and who makes a variety of excellent articles for practical use in camping, did not compete, inasmuch as he acted as expert for the jury.

We find Mr. Clair-Leproust here again with a fine show of small, light, portable, and elegant furniture, arm chairs, tables, and rocking chairs, which might be classed with those sent by Marks' Adjustable Folding Chair Company of the United States. Both obtained gold medals.

Rewards were also granted to certain foreigners who showed some traveling and camping requisites made and in use in their respective countries, although such articles were less interesting commercially than geographically. These queer looking, and in some respects curious, productions are doomed to disappear as fast as civilization distributes its benefits to the different parts of the globe.

CLASS 40.—TOYS.

Class 40 obtained the greatest possible success with the juvenile public. This corner was perhaps the most crowded of all, especially on Sundays. It did one good to hear those children; how they screamed with delight! and how happy they seemed to be! But now, with Christmas coming on, the choice of presents will be all the more difficult—so many dreams will call for realization, and so many promises will have to be kept.

Class 40 only occupied a small space, but what a lively amusing corner it was! It delighted everyone, not only little children, but big ones.

Immense progress has been made in this trade also within the last few years. Children are now catered for with the most infinite and incomparable talent. Inventors have never before shown so much ingenuity, and it has not been in vain. The large central exhibit, which standing apart from the rest attracted general attention, was that of Mr. Emile Jumeau, on the jury, and therefore out of competition. It contained large numbers of babies (the name given to the modern doll) of the most incredible richness, in every position, and so intelligent. These are French dolls unmistakably. The heads are Sèvres porcelain painted by real artists, and having luxuriant and silky hair. Their hats seem worthy of Linn or Viot, and their dresses are in the latest fashion, and made of rich Lyons silk of the latest style. Perhaps even they have set the fashion sometimes; if so, the best dressmakers of the day need not be ashamed. Little girls could not leave the spot, they were so fascinated.

Not far away and in the same style were the exhibits of Messrs. Steiner, Chevrot, and Rabery, who follow in the same lines as Mr. Jumeau. Mr. Steiner obtained a gold medal, and the others silver medals. Of course, in such aristocratic company we could hardly expect to find the poor child's dolly, the one whose glaring rags enliven thousands of miserable garrets, where 2 cents is all that can be spared for such a purpose. It would have been too bashful in such a place; and besides, such goods would have interested no one. The old-fashioned common sawdust, wood, or cardboard doll is kept down by its price, and remains stationary. As a rule nothing was shown in any section but the finest productions of the respective trades; the articles sent were in general accessible only to the rich, and if here and there a specimen of some ordinary article sold in the country was sent, it was hidden away in some corner of the cases.

The grand prize awarded to Messrs. Lefevre Brothers was the just recompense of years of labor in the improvement of painted tin toys—soldiers, boats, carriages, etc., so as to keep up with German makers. They have succeeded. They have an important plant with powerful steam engines, and are known as manufacturers of articles made of metal which can be put in the mouth and are painted with harmless colors. These would be sufficient reasons to assure them a wide reputation, but, in addition, they bestow special attention on the making up and packing of their goods. These results have not been obtained without great sacrifices of money and labor.

Amongst the gold medals mention should be made of the excellent colors and boxes of colors shown by Mr. Bourgeois, and the very excellent mechanical toys sent by Mr. Vichy. All our large American stores contain mechanical toys made by this ingenious and careful maker. The smoking figures and the beautiful waltzers, keeping

time to the music, which have so delighted our young lads and our fair girls alike, are all his make. Mr. Rossignol is another celebrated maker; it is he who, by cutting out and mounting machines, has succeeded in producing those very cheap mechanical toys—I think they come as low as 8 francs a gross—locomotives, trains, carriages, bread women, commissionnaires, etc., which have had such a run and are still so popular in the States. His mark, “C. R.,” is well known to toy men, and his goods are largely exported to America.

Amongst the members of the jury, and for that reason out of the ranks of competitors, I see the name of Mr. Derolland, the great India rubber toy manufacturer. His interesting exhibit contained a number of models well known in the States. There was the greatest possible variety in the faces; there were the Punches, soldiers, and little girls hanging from a thread and squeaking when squeezed; oxen, horses, donkeys, camels, dogs, cats, birds, all tastefully colored on the dull gray India rubber, which have emigrated by thousands to the banks of the Hudson or the Mississippi, carefully packed in small cardboard boxes. Messrs. Niquet & Bouchet (silver medal) make a similar class of goods. They showed some babies, *i. e.*, dolls, made of India rubber and dressed in nice woolen jerseys, besides many other goods in the same style as those sent by Mr. Derolland. Nor must I omit to refer to the gold medal awarded to Messrs. Villard & Weil for their tasty wooden furniture and what not for children; they were indeed far superior to anything of the kind made out of France. The reproduction of goats, sheep, and other animals, full size and having real skins or fleeces, is an important branch of this industry in France, and several makers have managed to make themselves a name in it, at the same time keeping prices down as low as possible. Mr. Crauser and Mr. Desportes, for instance, showed some very fine animals with bright gilded horns, trimmed with pink or blue ribbons, which make their respective cry when their head is bent down; they seemed to me to call for more than a bronze medal. Perhaps the reason was that little progress has been made in the trade since 1878.

I can not help saying a word about the scientific toys intended for the older children, whom nothing amuses so much as to make easy and amusing experiments in physics and chemistry. Certain manufacturers, who are very learned men in their way, avail themselves of the resources of photography, telephony, the elasticity of certain bodies, aërostatics, geography, history, steam, mechanics, the natural sciences, and the forces of nature, to produce some remarkable and most ingenious toys.

The instructive toys shown by the great publishing firm of Delagrave, the ships sent by Mallête, the instruments by Bassée Grosse, the toy theaters by Reynaud, and even Maning's spring horses, were

all curious and interesting things, as also were Brissouet's and Laurent's balloons and Lepierré's magic lanterns. Every little boy is half a soldier, so that the arms, guns, swords, cannons, panoplies, and pistols were all highly appreciated and well represented. Messrs. Chauvin, Bazin, and Blanchon were the chief exhibitors.

Every little girl is half a housewife. In this line we saw furnished houses made of metal and porcelain, battledores and shuttlecocks, graceful games, dolls' houses, watches and jewels, pictures and looking-glasses, haberdashery, and even the antiquated kaleidoscope. Messrs. Dumont, Carrière, Sevette, Rungaldier, Roulleau, Mercier, Poudra, Talon, Pean, Foliot, and Ouachée deserve our girls' best thanks. Mr. Jullien, who was the foreman of the jury in this class, showed some beautiful paper boxes, mercery, and cut-out work, which would certainly have been highly rewarded only that his office placed him out of competition.

Our quiet lads are still as eager as ever to exchange their stamps with one another, and Mr. Maury still supplies them with large quantities. He showed a rich collection of all colors and countries.

All the instruments of music, such as drums, tambourines, trumpets, fiddles, flutes, etc., whether made for elementary instruction or for children's amusement were exhibited, either by a very large firm, Messrs. Thibouville-Lamy, by Roulleau & Loiseau, or by Bigot, who sent a strange collection of musical instruments made of cardboard and producing the most laughable, absurd, unearthly sounds that ever fell upon the human ear; I believe they have been taken up by certain societies of rather noisy, jolly good fellows.

Two very good makers, Mr. Dutheil and Mr. Duhotoy, each sent good sets of children's carriages and dolls. Mr. Chenel's horses and carriages were remarkable in many respects, as also were Mr. Moncharmont's masks.

And now a last word about toys suitable both for children and grown-up persons. Mr. Janou and Mr. Jost showed those fine large race courses, which help to pass the time away in the casinos of our watering places. Messrs. Foin & Dumon also sent a fine collection of games, such as billiards, croquet, bowls, skittles, etc., which are so much appreciated in summer afternoons. Mr. Arthaud sent some fine dominoes, dice, chess, draughts, and other similar games in bone and ivory. Mr. Hallé, the well-known maker of theatrical accessories, showed some gnomes, big heads, and sedan chairs for children.

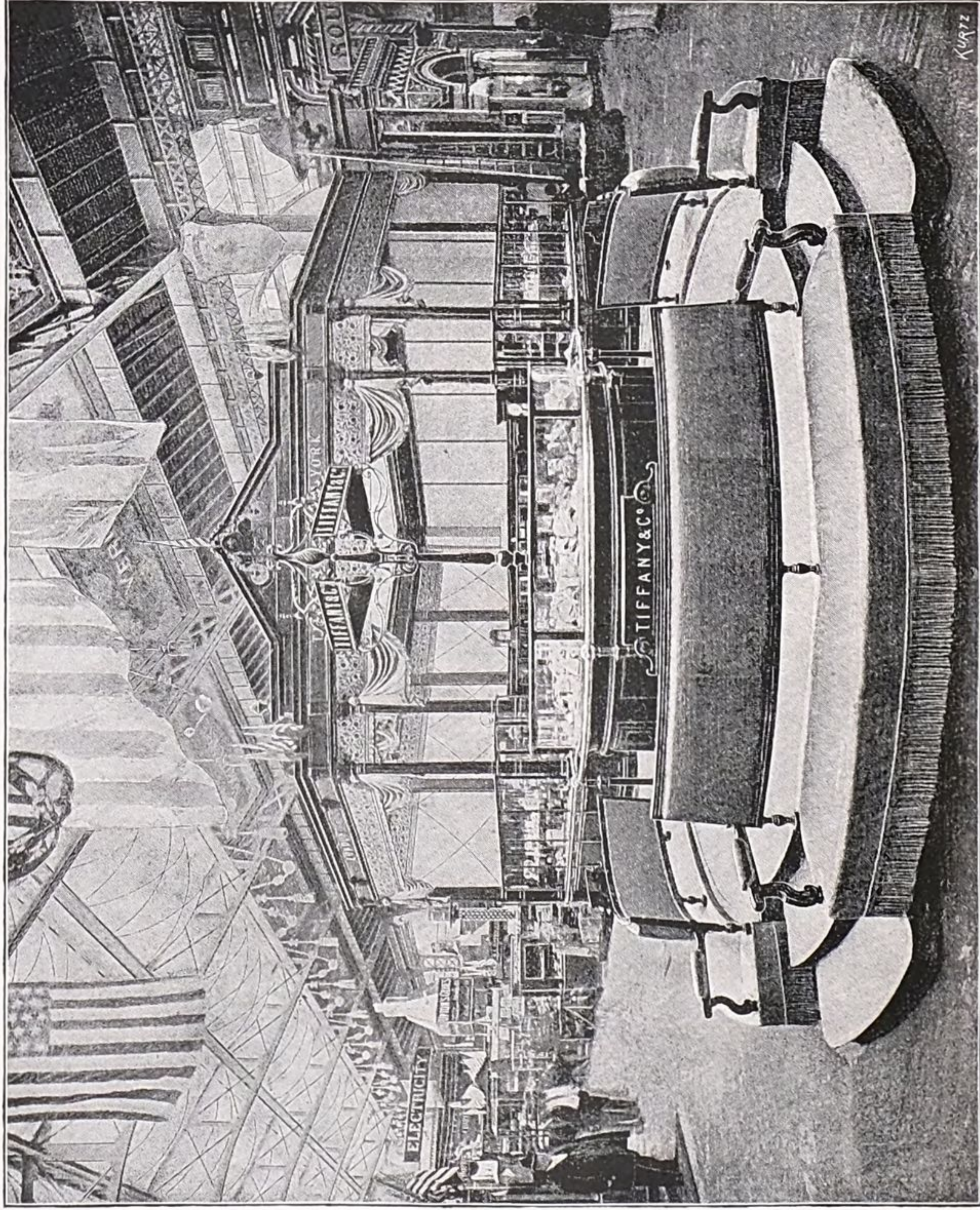
Among the toys sent by foreign countries we noticed some which had a fanciful turn and possessed a certain legendary interest, but nothing calling for special remark, unless it was perhaps some Chinese and Japanese dolls with strangely expressive faces, but they were intended for the theater and not to amuse children.

CONCLUSION.

I am afraid in this short summary I may have missed many things and omitted many names, but I have been as brief as possible so as not to tire the reader. The articles unmentioned through oversight can not, of course, speak for themselves, but if I have neglected to mention persons worthy of note here, I may be exposed to some little annoyance and perhaps to ill feeling on their part, which might break in upon my usual quiet life. I hope, however, it will be clearly understood that I have not wished to dissatisfy any one, and that I do not by any means pretend that this is a literary production.

I have tried to give a little accurate information which I hope may be of service to Americans. My countrymen can not, I am sure, in the course of their flying visits to Paris form a very correct opinion as to the actual situation of French industry, and I have been anxious to give them some idea of the astonishing progress it has made in the last twelve years, which progress, I am happy to say has been universal.

If I have succeeded to some extent, I shall consider that my labor has not been in vain, and any little unpleasantness I may have brought upon myself will weigh lightly upon me.



JEWELRY.

No. 1. VIEW OF TIFFANY & CO.'S BOOTH AND CENTRAL CASE, CONTAINING COLLECTION OF GEMS AND PRECIOUS STONES OF NORTH AMERICA.

REPORT UPON JEWELRY.

By GEORGE F. KUNZ.

In the center of the French jewelry section, Class 37, was exhibited the Imperial or Victoria diamond at one of the four central corners, by Bapst & Falize, the historic Sancy diamond, weighing 41 carats, and a necklace composed of pink, blue, yellow, brown, black, and other colored diamonds. This section contained an immense number of fine and curious diamonds, rubies, emeralds, and other precious stones, as well as several interesting lapidary exhibits, and nearly fifty exhibits of imitation stones of all kinds, imitation pearls, etc. A carved diamond turtle, a fly, and some curiously drilled diamonds, were of more than ordinary interest.

The Imperial diamond was found at the Cape diamond fields and weighed originally 457 carats. The weight at present after cutting is 180 carats, 74 more than the Kohinoor, and 44 more than the Regent. It is held by a syndicate of French and English jewelers.

At the Exposition there were three exhibits at which the branches of cutting and polishing were carried on. At the Holland pavilion the display made by Boas, of Amsterdam, had a number of polishing wheels, the motive power of which was steam, as well as a machine reconstructed, showing the manner in which man-power was utilized in the eighteenth century. With this exhibit there was a large series, illustrating the various forms of cutting the brilliant, rose and table, as well as all the forms of rough diamonds, such as cleavages, splints, those for glass-cutting, and shaped for especially adapted tools.

Two Belgians exhibited diamonds—one, Latinie, a perfect yellow octahedral diamond weighing 300 carats; a diamond cross cut from a single stone (which is not unique, as claimed by the exhibitor, for such a stone was contained in the Hope collection, and was illustrated in the Hope catalogue of 1839); some fanciful and curiously cut brilliants; a small sword cut out of three diamonds; and the name of the exhibitor in table diamonds, seventeen of which were nearly an inch in length.

In the main aisle, Coutermans, of Antwerp, had an exhibit with the polishing wheels, an exhibit of the diamonds in the altered kim-

berlite, and a black diamond weighing 30 carats, which, it was reported, had been purchased by the Shah, but of which in reality he only inquired the price.

The most important exhibit was that in the United Diamond Mines Building, in which every process connected with the mining and cutting of the diamond could be seen under one roof.

First, the large sacks of earth, were thrown upon a screen, which sifted the material into a large washing-pan, or "compound," as it is called, about 15 feet in diameter. In this compound all the soft mud, light particles of shale, kimberlite, quartz, calcite, and other minerals whose specific gravity is less than that of the diamond were floated out, and in the center the diamond, garnet, pyroxene, and heavier minerals were concentrated. These concentrates were then carefully sorted, the garnets and the diamonds being the only ones of value.

In connection with this exhibit were shown models, or, rather, reproductions, made of earth, and small models, exact duplicates of the machinery and the tunnel systems used at the mines.

The De Beers Consolidated Mines exhibited, in a large central case, 5,138 carats of rough diamonds. This case was securely covered with an iron cage, like a parrot-cage in form, and from the maker of the caging in which the Kohinoor diamond was exhibited at the London Exposition of 1851. In this exhibit was a cut diamond, the largest brilliant in the world, weighing $228\frac{1}{2}$ carats, which in the rough had weighed over 400 carats; one large octahedral crystal weighing 306 carats, and a collection of 983 carats of fancy-colored crystals, of white, mauve, pink, orange, yellow, brown, and black; also a large number of distorted and curious crystals. The Bulfontein Mine exhibited 11,227 carats of rough diamonds, and the Griqua Land West Diamond Mining Company a parcel of 45,003 carats.

At the opening of the Exposition the diamonds were valued at 22 shillings a carat, and at its close at 38 shillings, so great has been the advance in the price of rough diamonds. One thousand sacks of diamond earth were washed at the Exposition, and the average amount of diamond found was $1\frac{1}{2}$ carats to a load of earth.

In connection with this exhibit was the cutting of diamonds, carried on by M. Roulina, who reintroduced diamond cutting in France, and is one of the few men abroad who has utilized a machine for the process. This machine, however, is very primitive in comparison with the more perfect one invented 15 years ago in the United States and in use here since. There were also diamond-piercing machines in operation. These required from 20 to 30 days to pierce a diamond of about 2 millimetres in thickness.

Not without interest was a diamond which had been a beautiful white stone of about 9 carats, but which was shattered into fragments while undergoing the polishing process on the wheel.

In the French jewelers' section was exhibited what was perhaps the most remarkable collection of jewelry and precious stones ever shown at one time. Beginning with the Imperial diamond in the center aisle, which the owners claim outrivals the famous Regent's diamond of the former exhibition, we find other notable French jewelry; seen at its best, although the gems shown may have been finer and larger, and the jewelry more faultless, so slight was the advancement over that of 1878, that to anyone having seen both, the present seems scarcely more than a rearrangement.

The tendency of the entire French jewelry seemed to have been a faultless reproduction of Louis XIV, Louis XV, and Louis XVI jewels.

It is in "figure work," that is to say, in representations of the human figure, that the French excel. Whether in metal work, wood-carving, plaster, stone, or in painting, they use the human figure with an amount of freedom, skill, and success which is most striking, as well as worthy of emulation. Their taste in colors, as in mural decorations, for instance, is also very notable, even if we make proper allowance for the fact that the decorations of the exhibition have no doubt been executed by the best of French workmen. It is the exercise of this taste and skill which gives the French manufacturers of bronze their preëminence. There is nothing in the materials or processes of manufacture with which we are unacquainted, or with which we can not become acquainted if we think fit, yet it would appear that we are not able to produce designs of sufficient merit to compete in the markets of the world with the bronze manufactures of Paris.

A *répoussé* plaque and one or two small stands, however, were fully worthy of the best Christofle traditions. They were not, as a group, equaled in the Exhibition; they have never been surpassed by any previous work of the great house itself—these were the statuettes, whether purely ornamental or for cups and prizes. Of the former, a female figure in ivory and gold was a miniature perfection, as beautiful as anything possible in marble, and of the greatest refinement. The figure could not be too closely scrutinized. The productions of Christofle's atelier were emphatically works of art, and whether of men or of animals, the modeling was perfect. They were equally easy and lifelike in repose or in action, and they told their tale as plainly and as charmingly as the marble or the figure painting of the great men of the fine arts.

Boucheron, Bapst & Falize, and Vever, and Sandoz occupied the four corners of the jewelry section. Boucheron's exhibit was remarkable for its delicate and faultless diamond mountings, fine pearls, large sapphires, and marvelous gems, as well as for some superb pieces of enameled work; Bapst & Falize for their jeweled pieces, among which were reproductions of those made a century ago

by the same firms, the latter exhibiting the original Sancy diamond in a setting similar to the one made for it in the eighteenth century in the time of Marie Leczinski.

Vever's exhibit was remarkable for the necklace of colored diamonds and for his fine gems rather than for the fine work exhibited. He showed a variety of artistic pieces; one of the most charming was a hand mirror adorned with a fine foliage in chased green gold on a yellow background. The handle of this consisted of two tails of mermaids entwined in a snakelike way, at the base of which was a pink pearl.

In passing through the jewelers' section let us notice Teterger's spray of geraniums in enamel, of so perfect a rendering, so light and natural. Gustave Sandoz exhibits some lovely pieces. His corsage garniture in the shape of a bold yet regular ornament, bordering the top of a low-neck bodice, and gracefully coursing down to the center of the waist, has an elegant effect. His bracelet, divided in small pieces and decorated in enamel of a tender hue, is very pretty. A rather attractive glass case is that of Mr. Fornet, of Bourg-en-Bresse (near Lyons), who exhibits some special kinds of articles called "Emaux Bressans," whose style was already known and in very great favor in the Gallo-Roman period. They consist of rings, brooches, bracelets, earrings, necklaces, etc., in vermeil filagree and enamel. The center of the display is occupied by a fine little mirror, underneath which we remark an inkstand of pretty design. Mr. Fornet has greatly changed that peculiar *genre* from the old-fashioned style, and it is now somewhat different, chiefly consisting of enamel on champleve. Although that abandonment of an ancient track may be amply justified from a business point of view, yet one can not help regretting the old crosses in the shape of a double hatchet, the hearts with pendants, the rings so naïvely ornamented, and the varicolored jewels called *papillons* which, not many years ago, were still worn in the southern part of France.

EFFORTS TO REVIVE ENAMEL WORK.

Our high-class jewelers and goldsmiths are making serious efforts to revive the fashion for enamel work, and among them Froment Meurice, Poussielgue-Rusand, Bapst et Falize, Boucheron, and Vever, have already obtained some remarkable results. Enamel has never been utterly abandoned by jewelers, who have lately made some dainty pieces in that line, but goldsmiths and *orfèvres-bronziers* for churches had for many years somewhat neglected it. All attempts to revive it had proved very unsatisfactory. There seemed to prevail a general belief that the art of Leonard Limouzin, Penicaud, and Raymond must be considered extinct. A few years back some enterprising artists endeavored to find out the old secrets and,

little by little, they came to the conclusion that what had been done centuries ago could be done quite as well at the present day, on condition that enamelists could find patrons to encourage their efforts.

Unfortunate attempts were made some time ago by several silver-smiths to introduce enamel into articles of daily use. Goblets and breakfast cups so adorned were sold to maybe careless customers, who soon brought them back to their makers in a very bad condition, and could not be made to understand that such repairs must be very expensive.

I have seen some of these pieces; most of them consisted of Renaissance ornaments, finished off in oxidized silver, whose backgrounds and intervals, previously hollowed by the aquafortis process, had been filled up with the enamel of well-opposed colors. The work was obtained at a rather reasonable price; but I must say that it would not bear a very close inspection. No doubt our old artists were right in removing the metal (which had to make room for enamel) by the help of several gravers, variously edged for that purpose. By so doing they managed with their skillful hands to finish their pieces to a nicety. Until we find another process, allowing us to do the same work quite as well but much quicker, we had better follow their example.

Strange to say that although competent, the French jewelers were given awards according to the quality of their articles exhibited, yet many of them were not makers but simply purchasers and exhibitors of jewelry that they had selected from designs shown them and which had been made by jewelers who are simply manufacturers and not retailers.

From amethyst episcopal rings to cathedral *reliquaires de St. Louis* altar pieces, and sanctuary gates, in no case does the lavish use of gold, jewels, and metal, engraver, or carving in chisel lead to tawdry splendor. Even as gathered together in one mass of burnished gold and precious stones the effect was wondrously "rich, not gaudy," and as used in the more gorgeous ceremonials of the Catholic Church the magnificence would be thoroughly harmonious.

Blais & Cie., P. Brunet, and Armand Galliat are the principal exponents of *l'orfèvrerie religieuse*, and seem much on a level.

The Norway and Sweden section consisted of almost entirely highly colored enameled work very like the Russian and a reproduction of the old Norway and Swedish designs.

The jewelry in the American section, although exhibited by only one firm, Tiffany & Co., of New York, was remarkable in the fact that it was entirely produced in the workshop of the exhibitor. It numbered in all about two hundred pieces, of which no two were alike, and the variety of objects represented every branch of the jeweler's art. Specimens of the gold work, representing the most intricate carving, chasing, wire filagree and other forms as well as

delicate colors of the gold, helped to show off the precious stones, pearls, as well as the enameled flowers, the quaintly cut stones and the subjects, which were remarkable for their originality.

The enameled orchids, as well as the *mignonette*, a marvel of gold and enameling, were perhaps one of the most striking features of the entire Exposition. The apple blossom watch and the enameled orchids, some two dozen in number, were all faithfully reproduced by careful studies direct from the living plants. First made by producing the model in soft unannealed silver, which, from its softness, could readily be shaped into a perfect facsimile of the flower and thus forming a permanent model for the worker. The colors of the flowers were copied by the coloring artist who produced not only the elaborate colored sketches, but reproduced the exact color of each petal by dissecting the flower. In the *mignonettes* the stamens had only the thickness of a hair, but had on them two distinct colors in enamel. The representation of the *heliotrope* was even more remarkable, for not only the flower, but the unopened buds, were perfectly simulated in green gold.

An enormous piece of diamond work was the *Garniture de Cor-sage*, containing 2,200 cut diamonds.

Two crystal vignettes and bonbon boxes made of rock crystal, from North Carolina, were remarkable not only for the jewel work and gold work but for the success in carving the rock crystal.

Among the more remarkable pieces of jewelry may be mentioned at random, a diamond necklace worth \$150,000; a diamond necklace with a single stone in it weighing 77 carats; a pearl necklace, value \$30,000; a sapphire pendant, value \$12,000; a *chrysolyte* watch and pendant in the Empire style, value \$3,000; a black pearl brooch containing eight of the finest pearls in the Exhibition; a pendant consisting of six Ceylonese cat's-eyes, value \$8,700—superb piece of East Indian gold work; a forget-me-not smelling bottle and watch in the spray of a blossom.

The objects themselves are for the most part manufactured from American metals, precious stones, skins, woods, and other American products, while the models themselves are due in many instances to direct studies from the *Chillkat*, *Sitka*, and *Inuits* Indians of Alaska, the *Zuni* and *Navajo* Indians from New Mexico, the *Sioux* Indians from Dakota, and the other Indian races of America.

The four *grand prix* were awarded for jewelry, Class 37. They were obtained by *Boucheron* and *Vever* for jewelry, by *Savard & fils* (imitation of jewelry), and by *Topard & Ruteau* for imitation stones. No *grand prix* for jewelry has ever been awarded to any foreigner.

A collection of precious and ornamental stones of North America, as well as a collection of foreign precious stones, was displayed by *Messrs. Tiffany & Co.* in the American section. The former collec-

tion was contained in a circular case 9 feet in diameter, on a platform erected at the intersection of the four aisles of the American section. This collection was formed for the purpose of illustrating the occurrences of the precious and ornamental stones in North America, and contained many of the finest examples that have been found, some unique, others entirely new. This collection was the result of purchase, completed by generous loans from some of our prominent mineralogists, and was an object of interest to the many visitors of the Exposition.

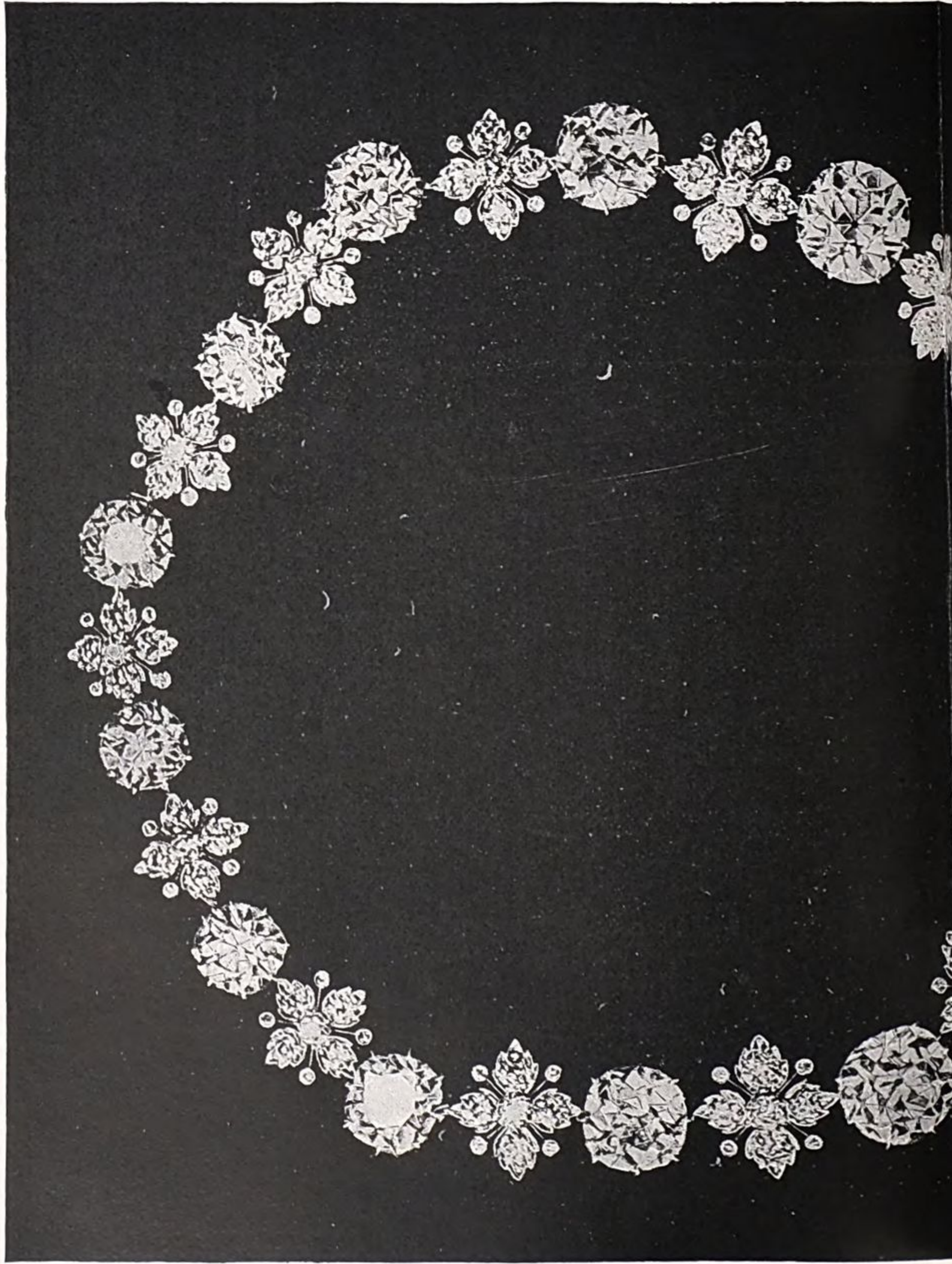
One of the features of the jewelry exhibit was the utilization of American stones and pearls in jewelry, notably tourmaline, beryls (yellow, green, and blue), rock crystal for vials and boxes, and pearls from the Unios in a large variety of objects, the motive as well as the materials employed being American in character.

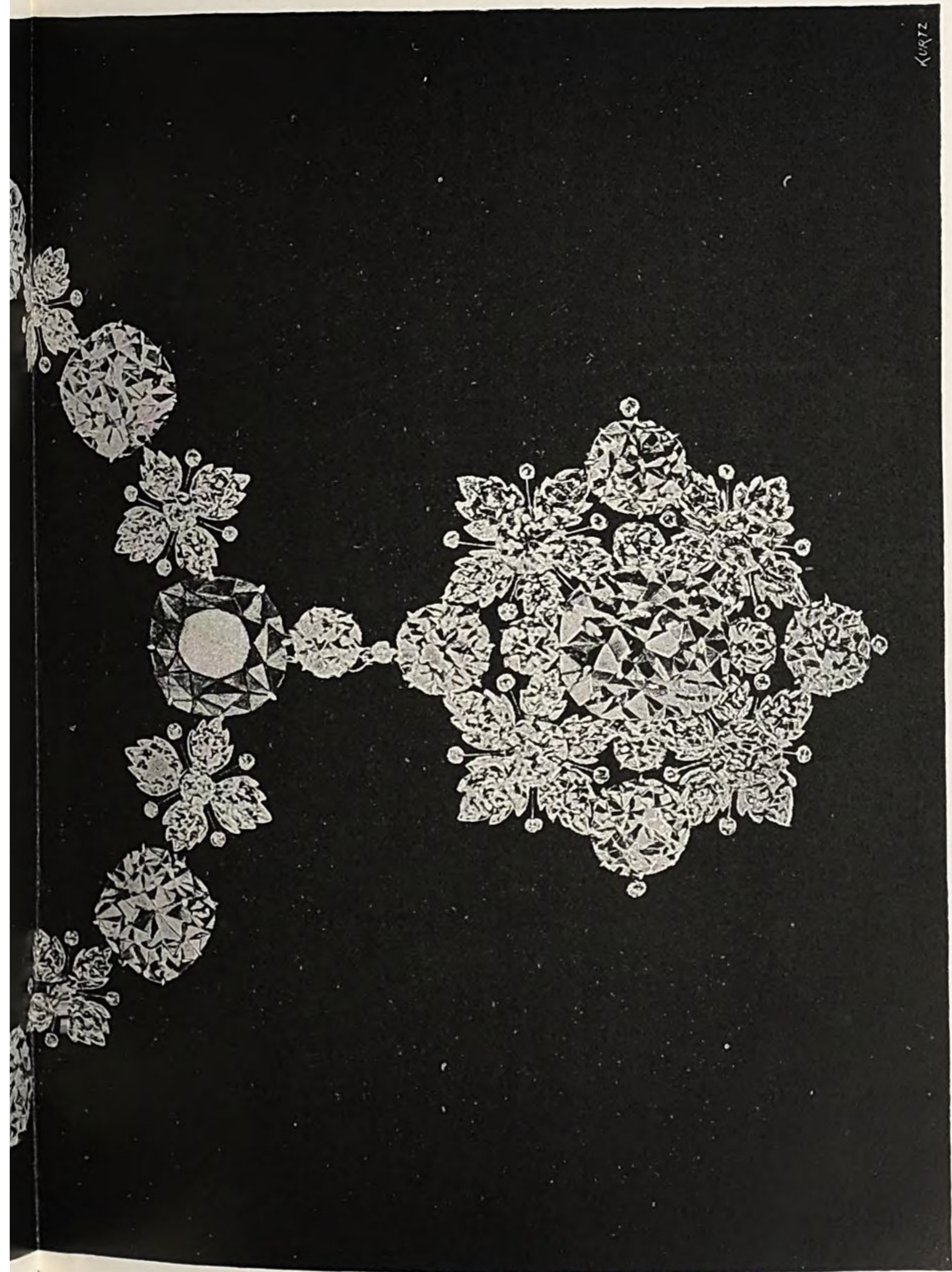
Among the more important things in this collection were some small diamonds from California, a series of the original crystals of sapphires collected by Col. C. W. Jenks when he opened the Jenks mine in Franklin, Macon county, North Carolina, among them the first sapphire found in the United States—a ruby of fair color; some American crystals and cut topaz from Cheyenne Mountain, Colorado; one of the largest crystals of emerald from Alexandria County, North Carolina, loaned by Mr. Bement; the cut aquamarine, weighing $133\frac{2}{3}$ carats, from Stoneham, Maine; thirteen cut aquamarines from Mount Antero, Colorado, found at an altitude of 14,000 feet above the sea; a number of cut spessartite garnets, one of which weighed $96\frac{1}{8}$ carats, from Amelia Courthouse, Virginia; a series of colored tourmalines, both cut and crystal form, from Mount Mica and from Auburn, Maine; a collection of pearls and the shells in which they are found on the shores and in the rivers and brooks of North America.

Some notable things in the Tiffany foreign collection were a series of twenty-four fancy-colored sapphires, weighing from 2 to 20 carats, and showing every color of the spectrum; some fine alexandrites, chrysoberyls, and zircons from Ceylon; crystals and cut euclase from Brazil and Siberia, and a number of interesting precious and ornamental stones.

PLATE XIX.

PARIS EXPOSITION OF 1889—Vol. 2.

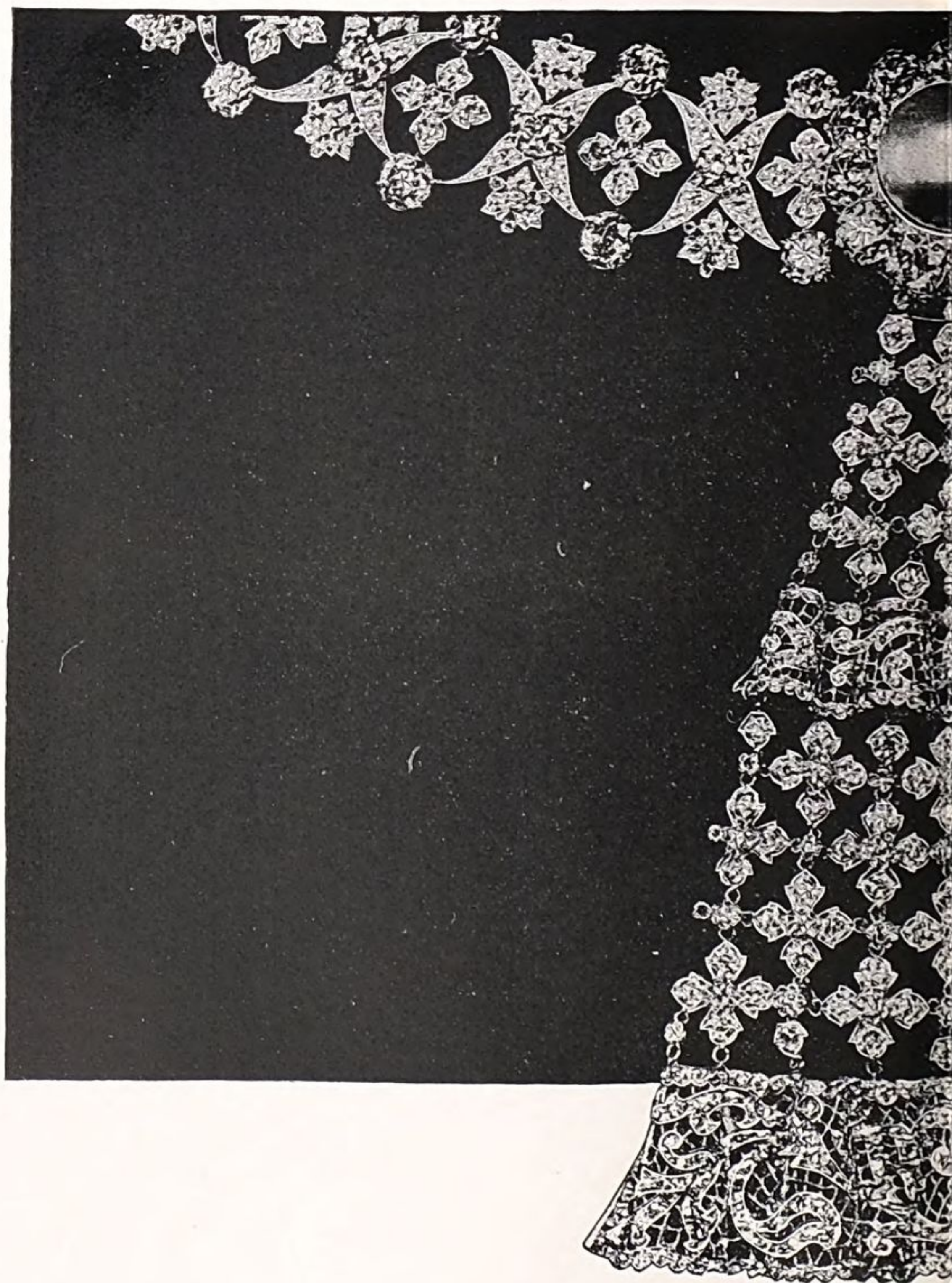




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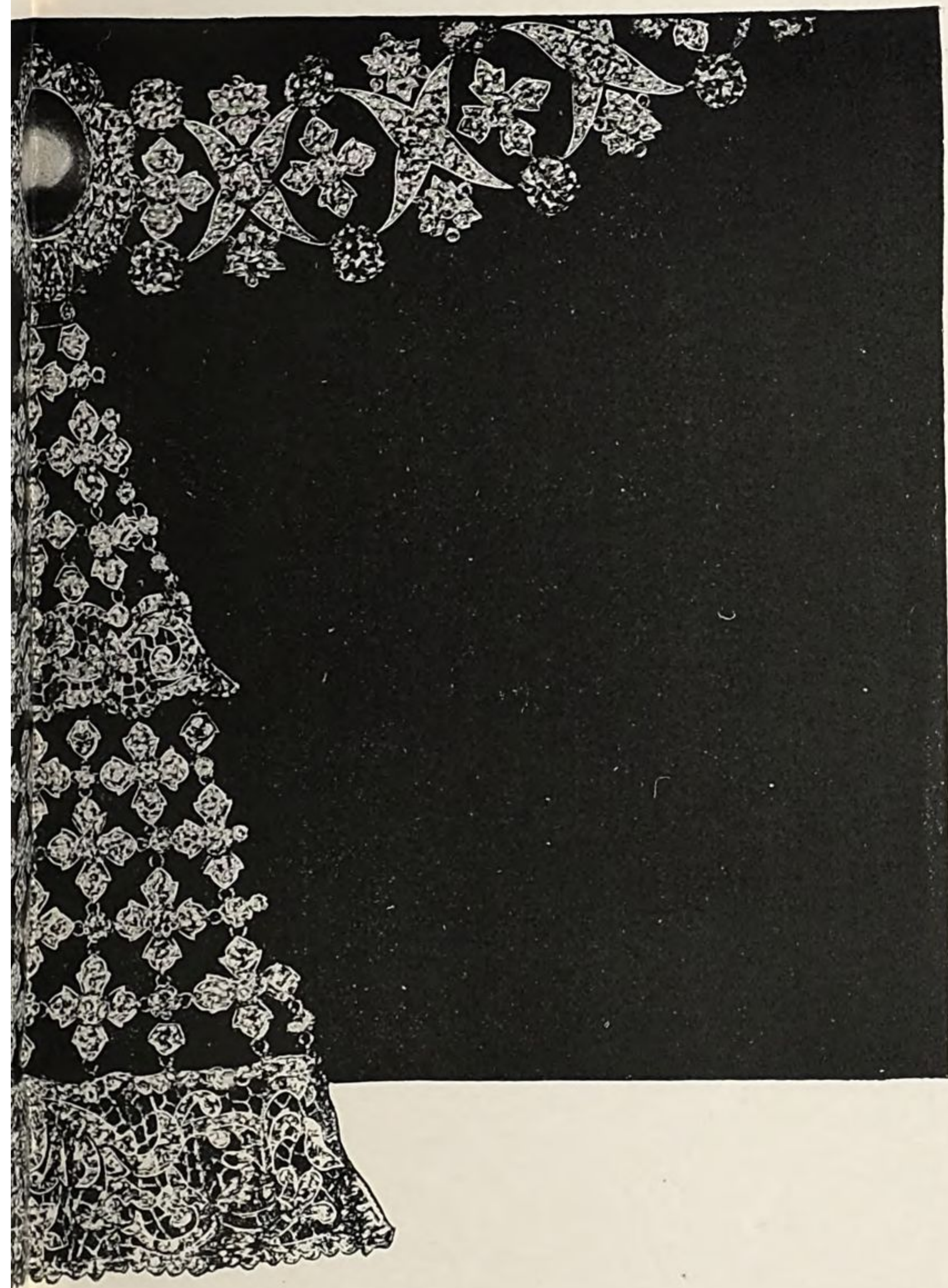
JEWELRY.

No. 2. THE MOST IMPORTANT DIAMOND NECKLACE AND PENDANT AT THE EXPOSITION.
Fine river brilliants, center stone $25\frac{3}{4}$ carats. Design, American hazel-nut bud. Value, \$150,000.



JEWELRY

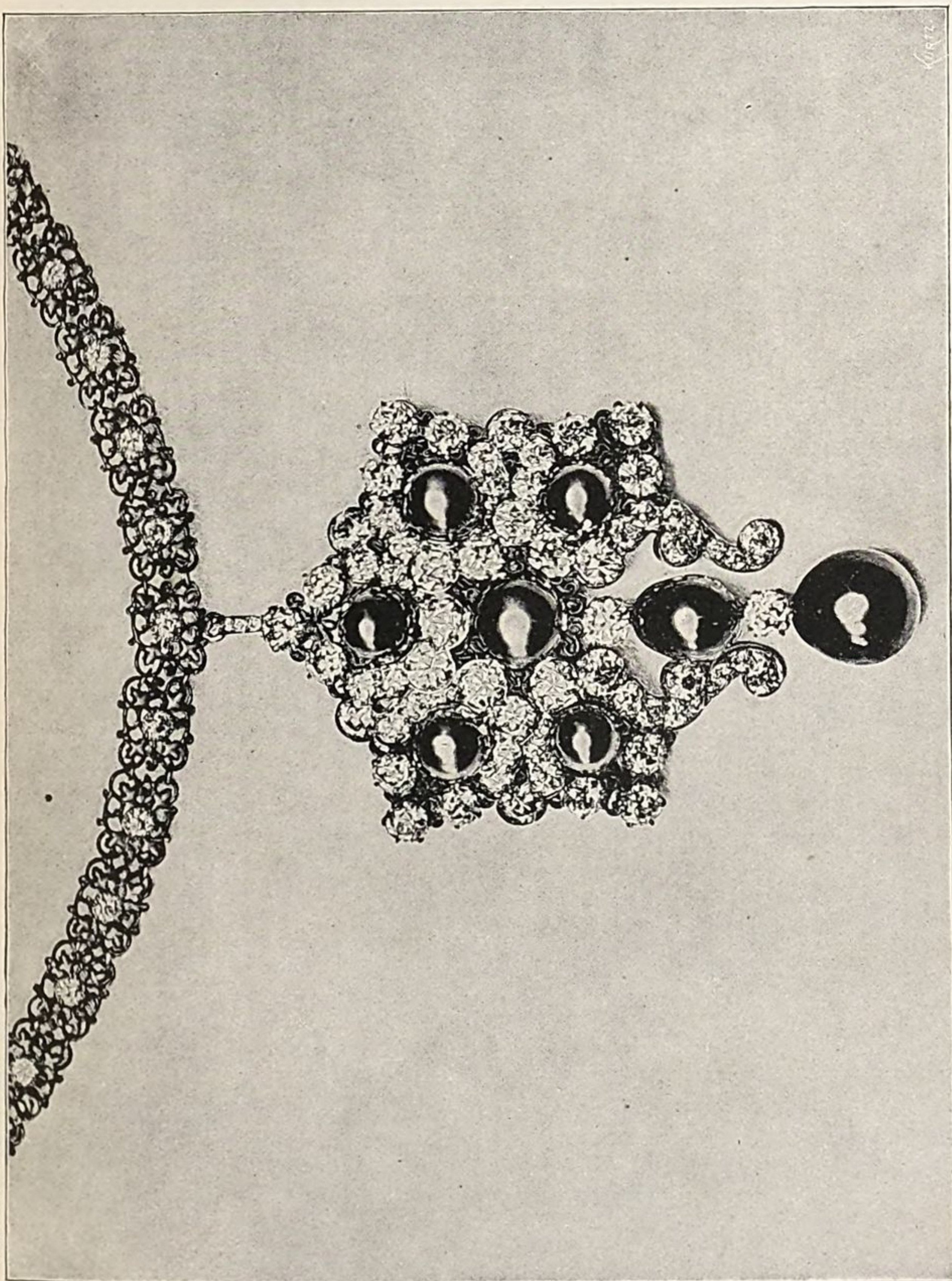
No. 3. NECKLACE,
Diamonds with pearls



JEWELRY.

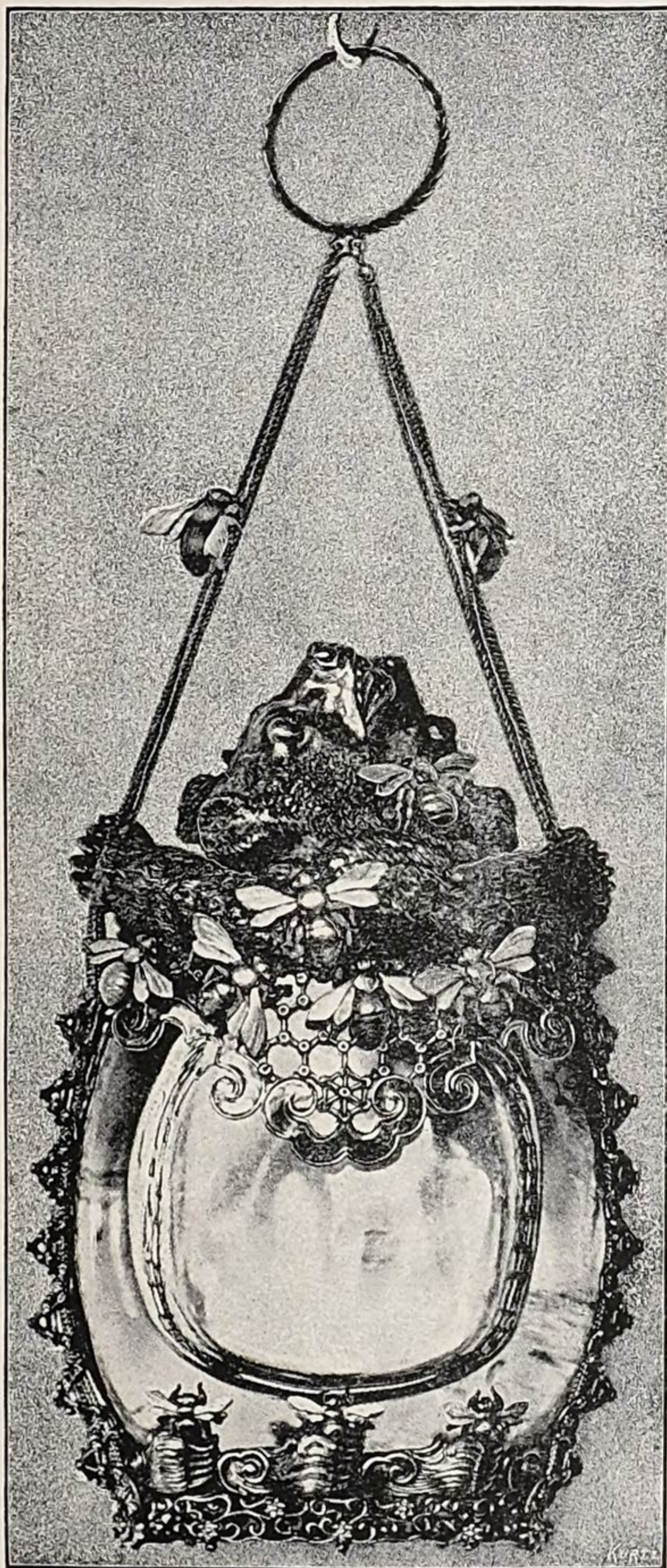
"EMPIRE STYLE."

center. Value, \$8,000.



JEWELRY.

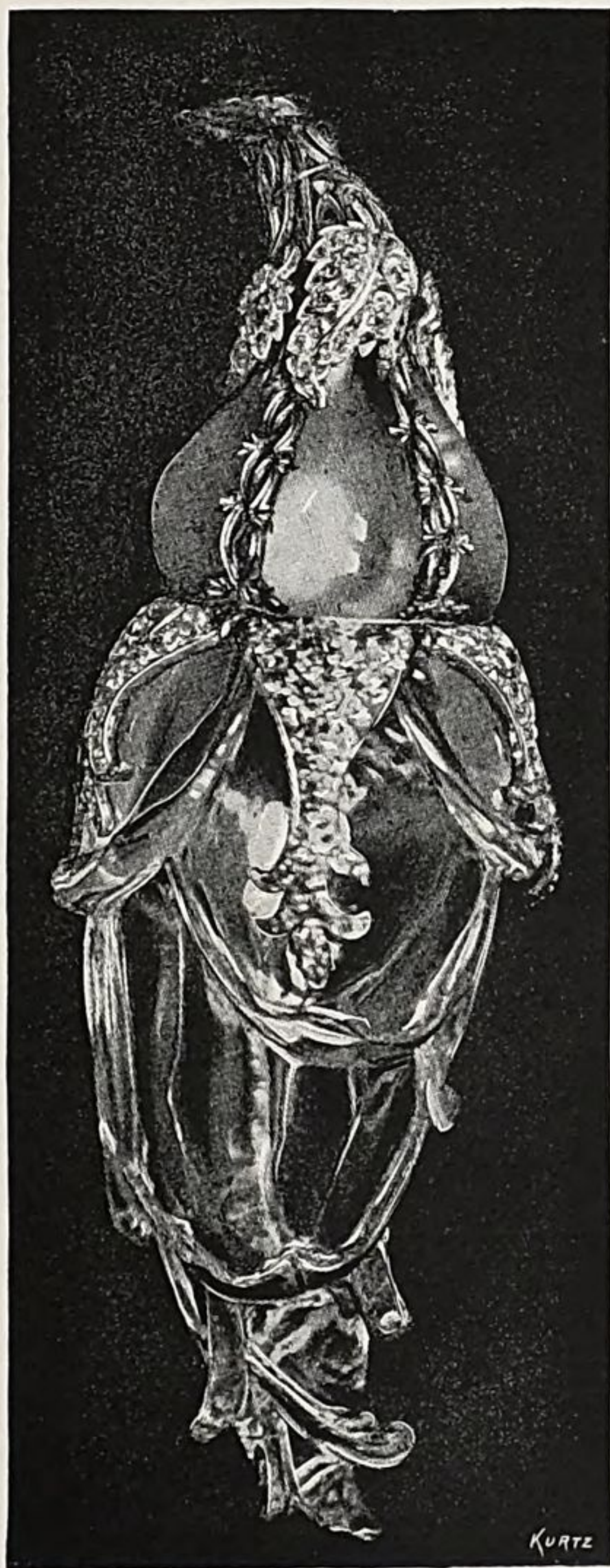
NO. 4. PENDENT BLACK PEARLS AND DIAMONDS.
Pearls from Gulf of California. Green black, fine luster.



JEWELRY.

No. 5. VINAIGRETTE—"BEAR AND BEES."

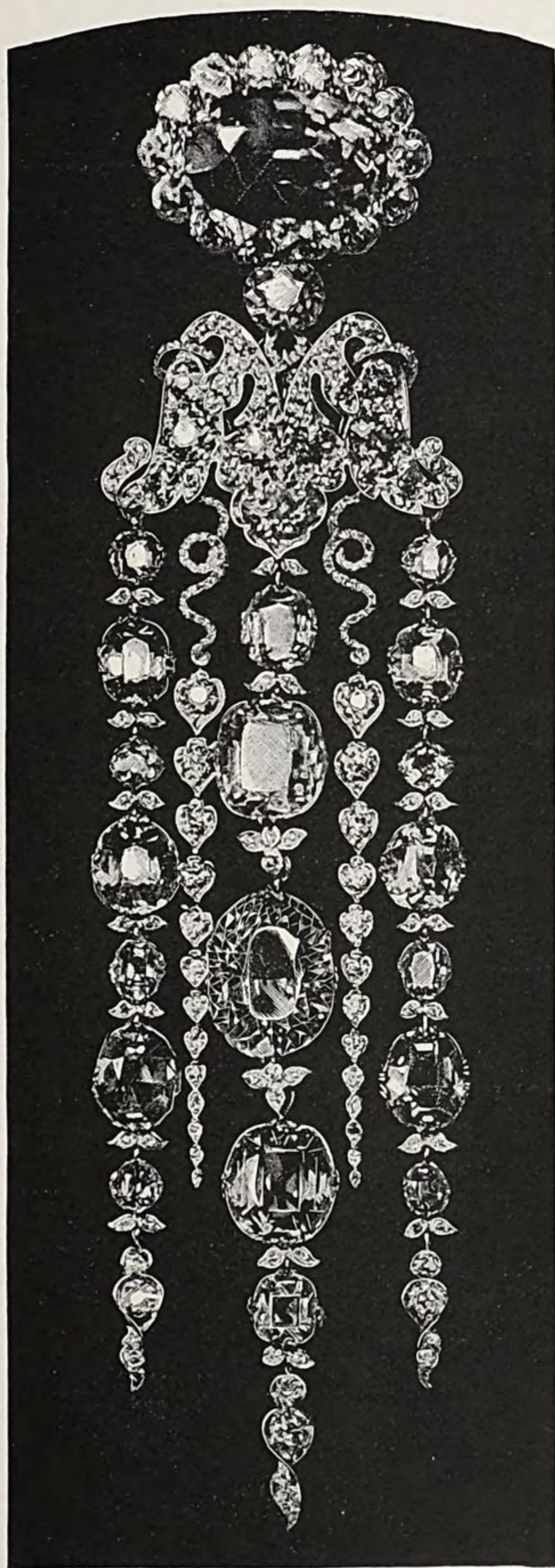
Bottle smoky crystal, North Carolina. Mounting in colored gold, Shodo, Shakado, and other Japanese metals.



JEWELRY.

No. 6. VINAIGRETTE—"ROSEBUD."

Stem-pierced gold work. The bulb five (5) large Ceylon moonstones, leaves diamonds, and the bud proper cut out of crystal from Ashe County, North Carolina.



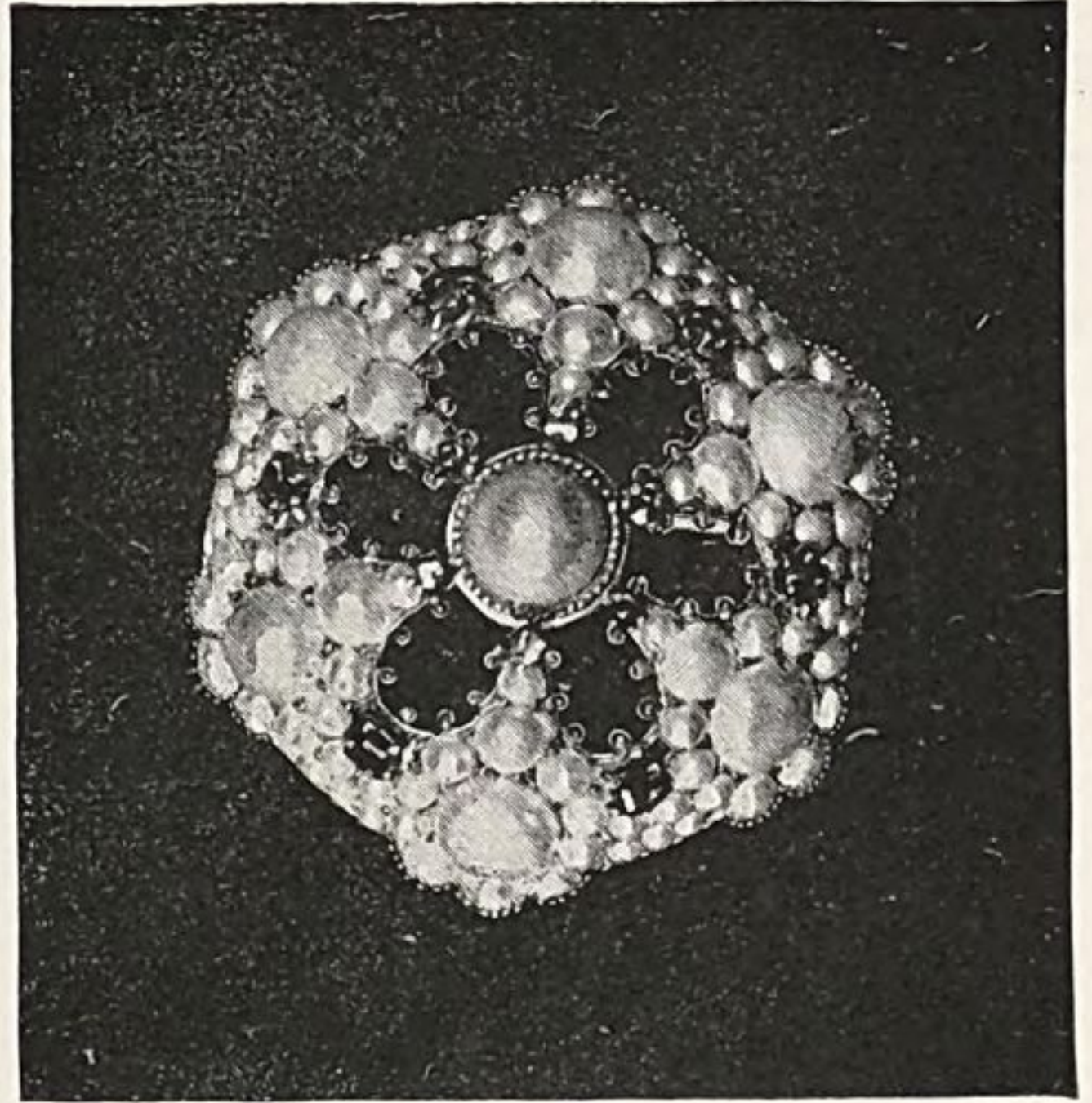
JEWELRY.

No. 7. SAPPHIRE AND DIAMOND PENDENT BROOCH.
Value, \$12,500.



No. 8. BROOCH—STUDY AFTER THE HUPA INDIAN STRAW BASKET WORK.

Garnets from Arizona and Amelia County, Virginia. Pendant enameled.



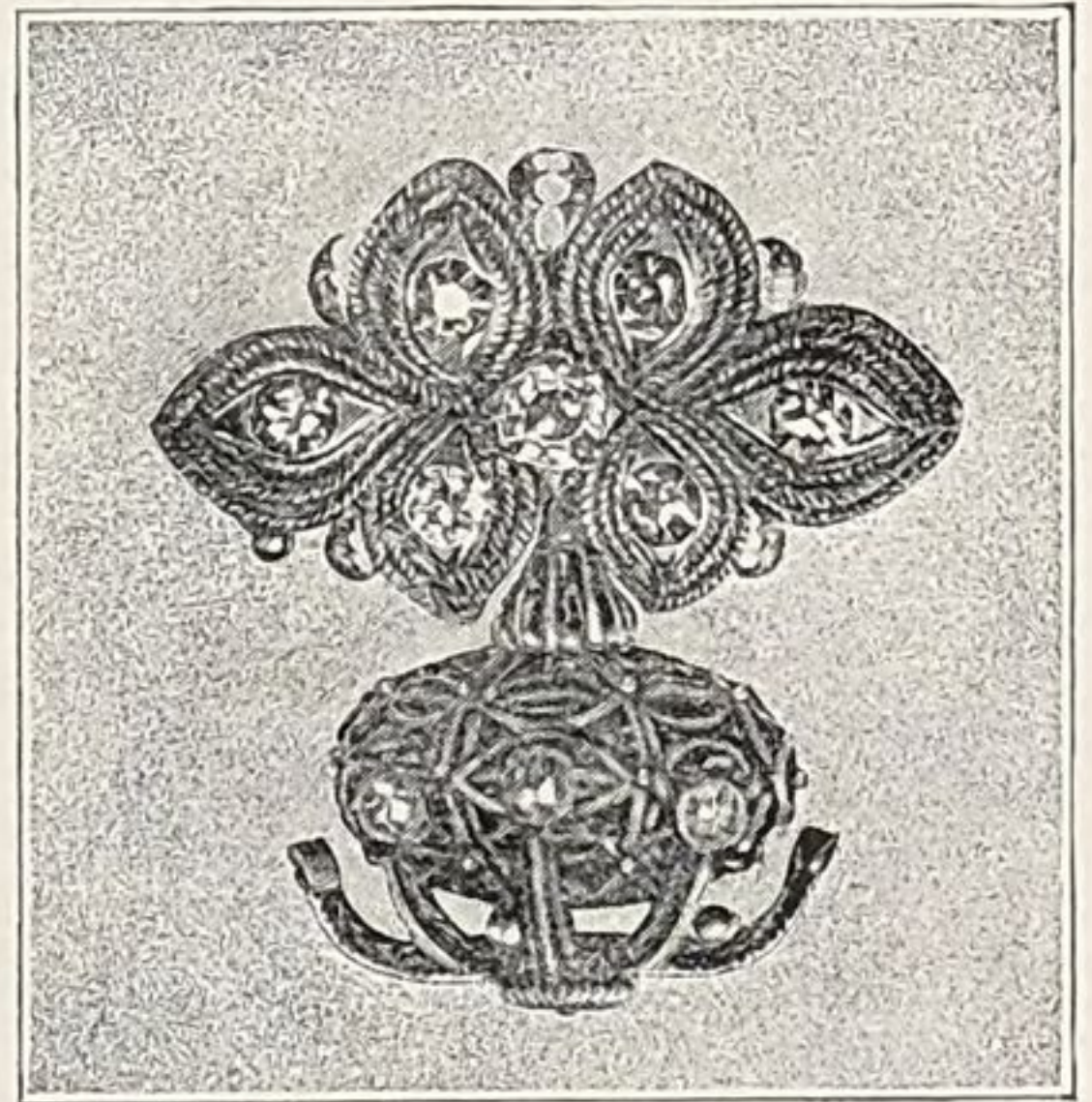
No. 9. BROOCH—STUDY FROM HORSE-HIDE SHIELD OF SIOUX INDIAN.

Round, high dome brooch, open section in center. Miami River white pearls. Tiny green shots of enamel toned with other colors.



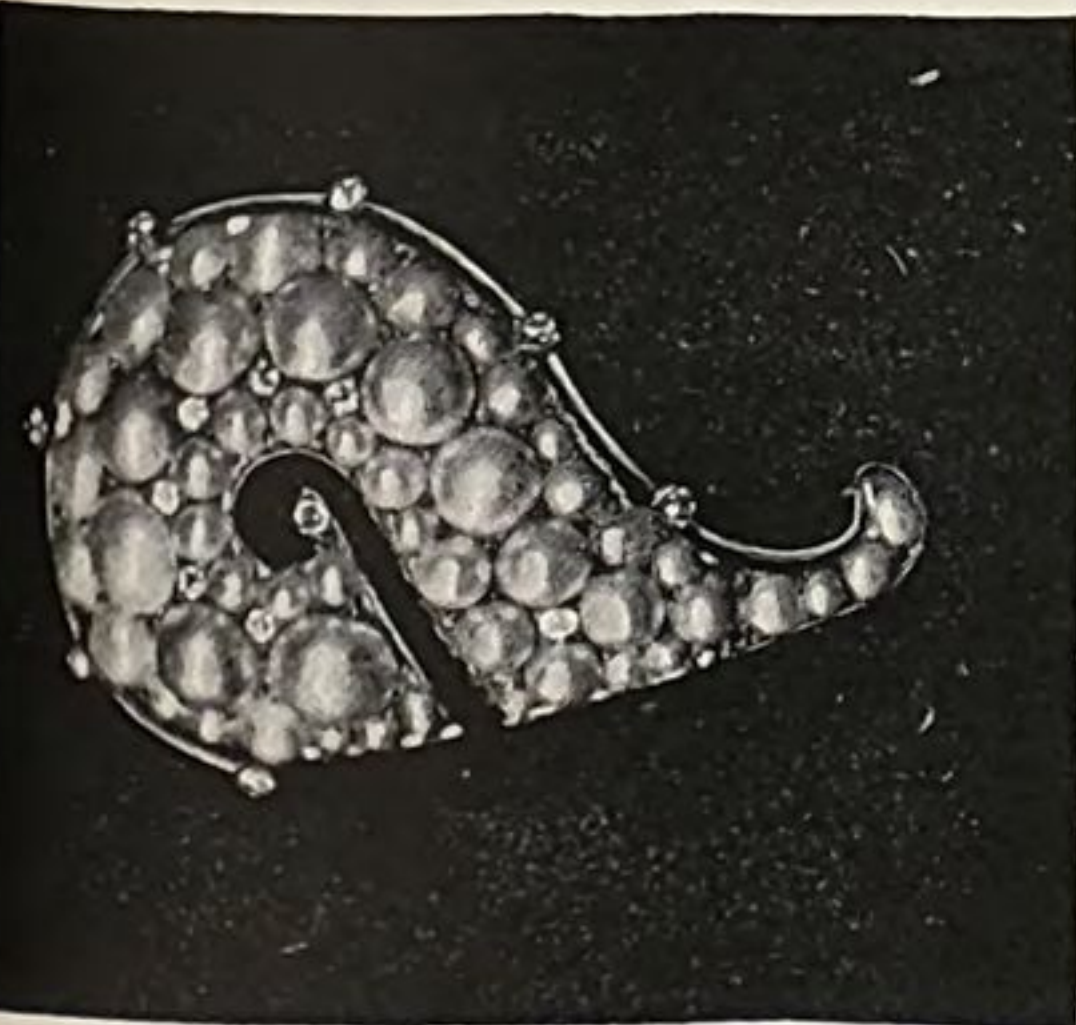
No. 10. BROOCH—STUDY AFTER "FLORIDA PALM."

Green sapphire from Montana. Pink American pearls from Miami River, Ohio. Enameled ornamentation of various colors.



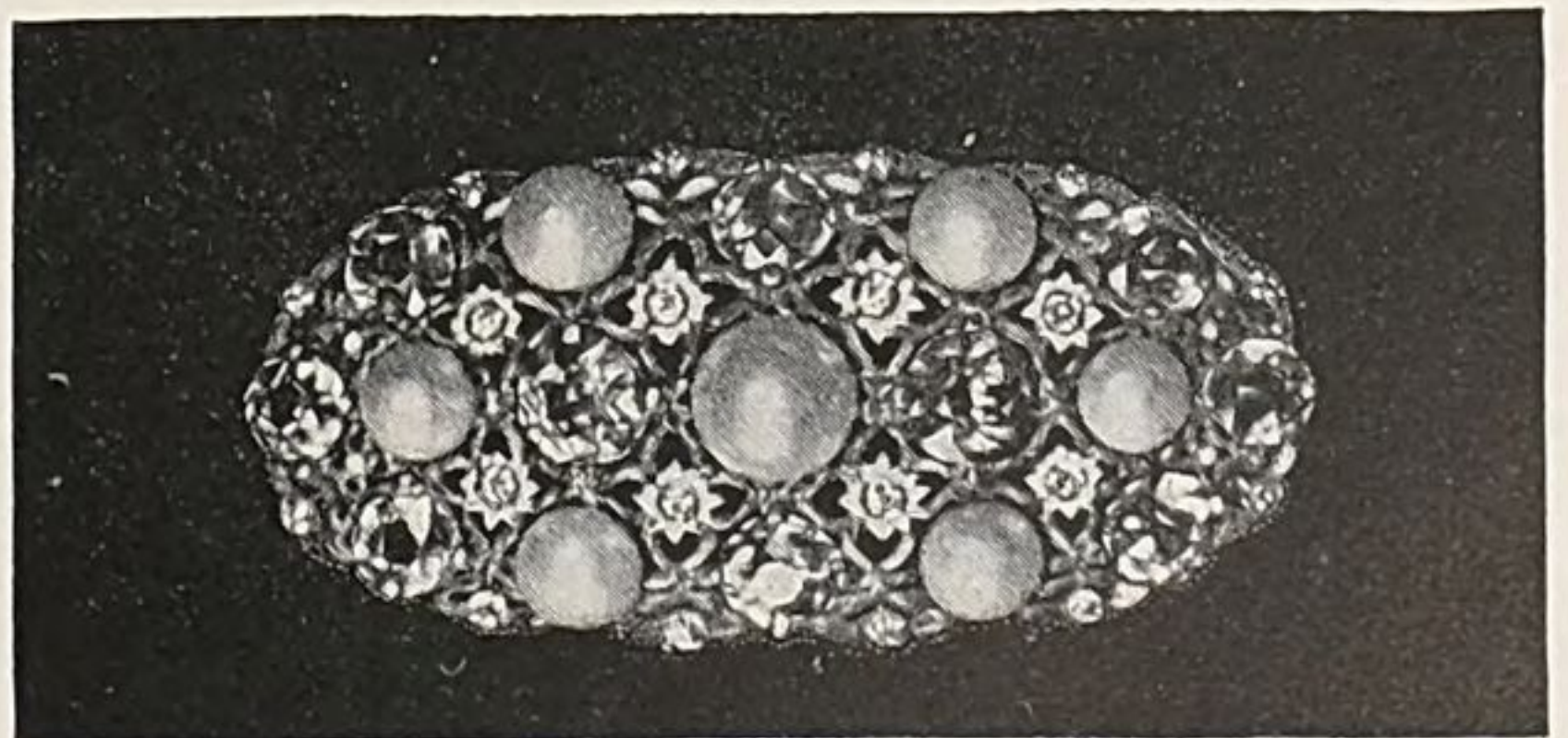
No. 11. BROOCH WITH PENDANT—STUDY FROM CHILKAT INDIAN BASKET WORK.

Fancy colored diamonds from Brazil, South Africa. Enameling after wood-carving Chilkat.



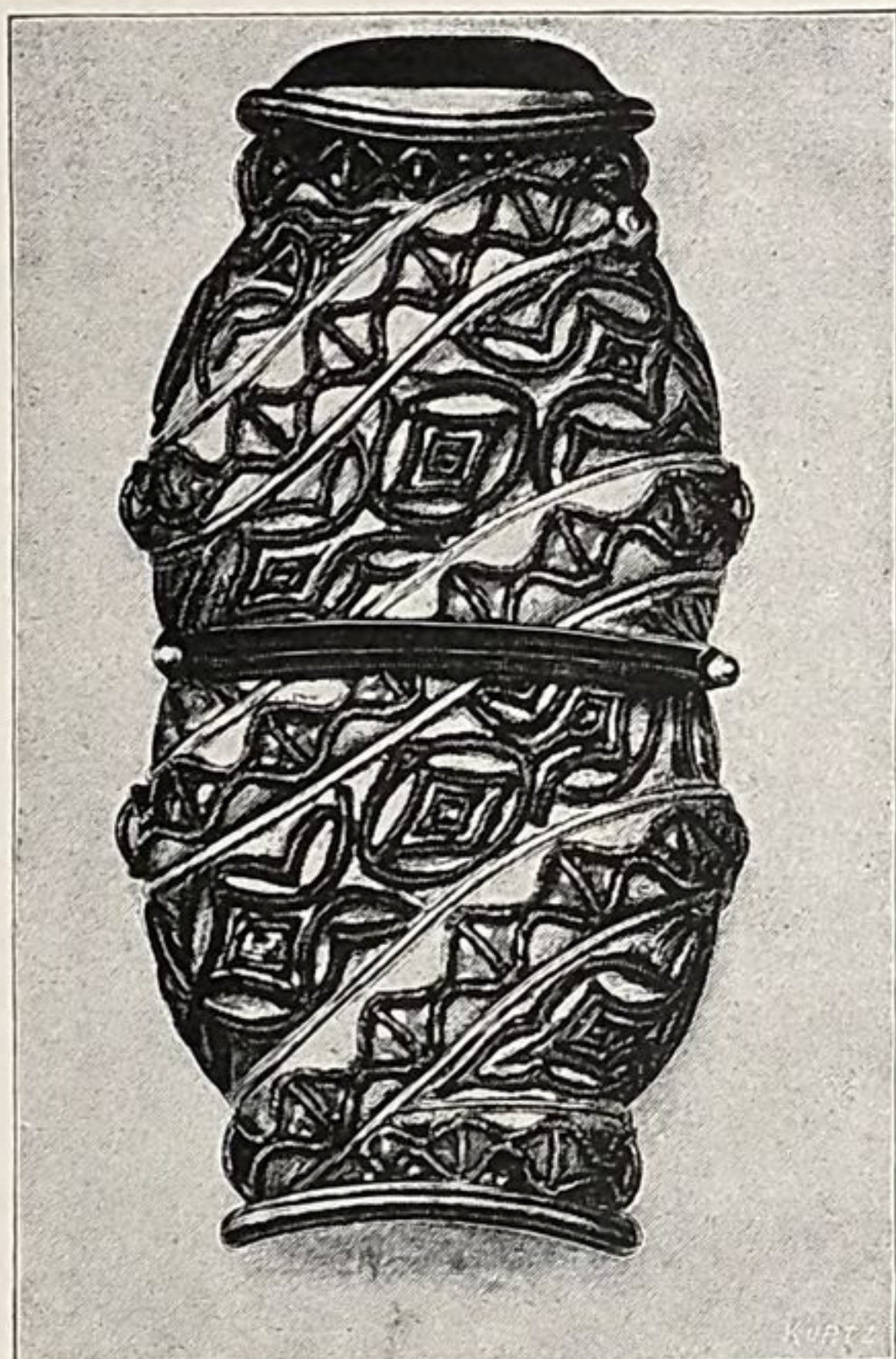
No. 12. BROOCH—STUDY FROM "HUPA INDIAN."

Pink pearls from Little Miami River, Ohio, with enamel and diamonds.



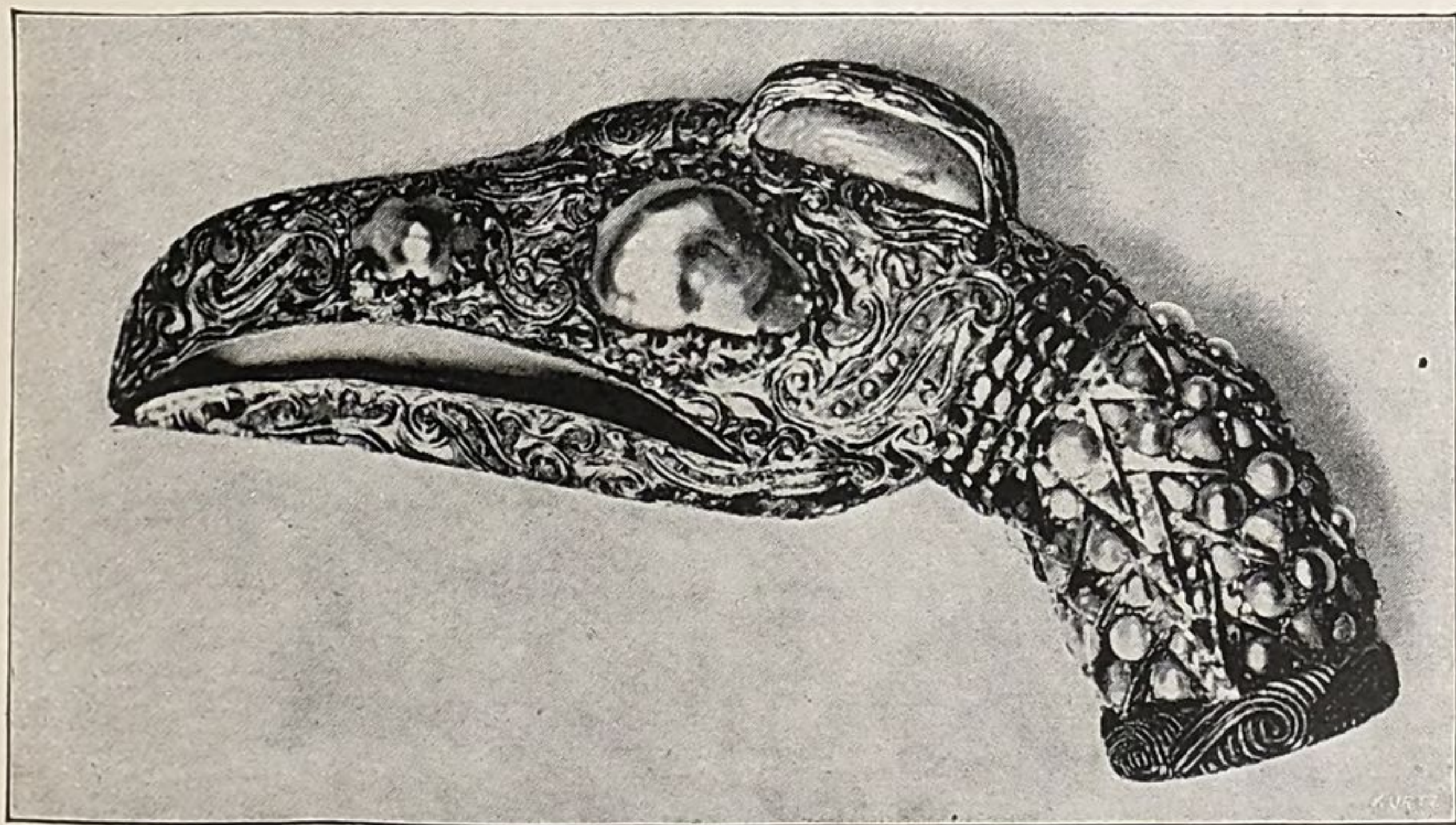
No. 13. BROOCH—STUDY FROM NAVAJO INDIAN.

Treatment of the New Mexico wood violet. Light bluish green, and white enamel with diamond centers. Pink pearls, Little Miami River, Ohio. Blue-green sapphires, Montana.



No. 14. MATCH SAFE—STUDY AFTER NAVAJO
INDIAN STRAW WORK.

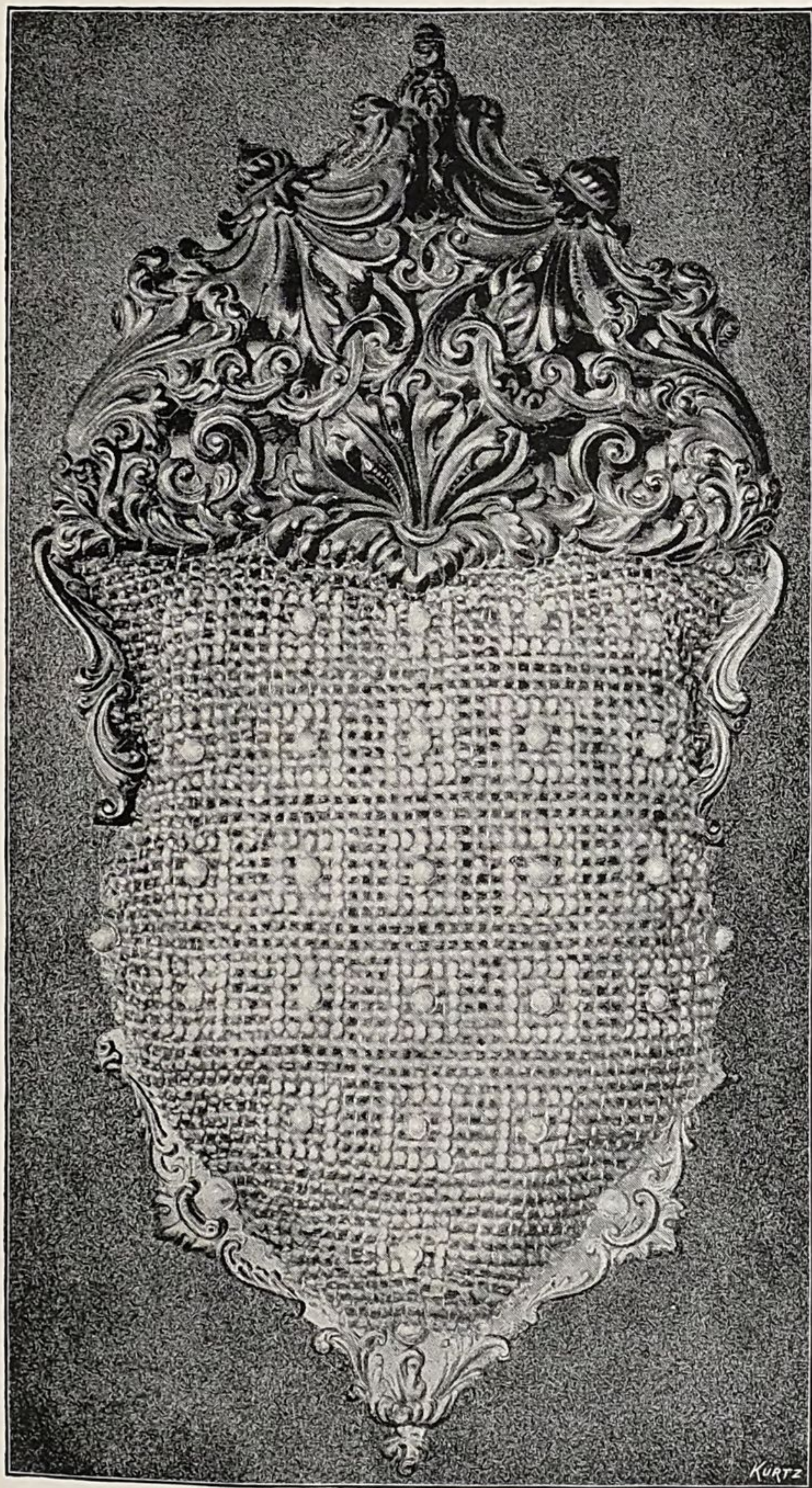
California gold quartz cut en Cabochon in top.



No. 15. UMBRELLA HANDLE—STUDY FROM A CHILKAT INDIAN EAGLE HEAD.

Rich chased gold diaper. Abalone pearls set in head. American turquoise in comb. American Miami River pearls in feather decoration on neck.

JEWELRY.



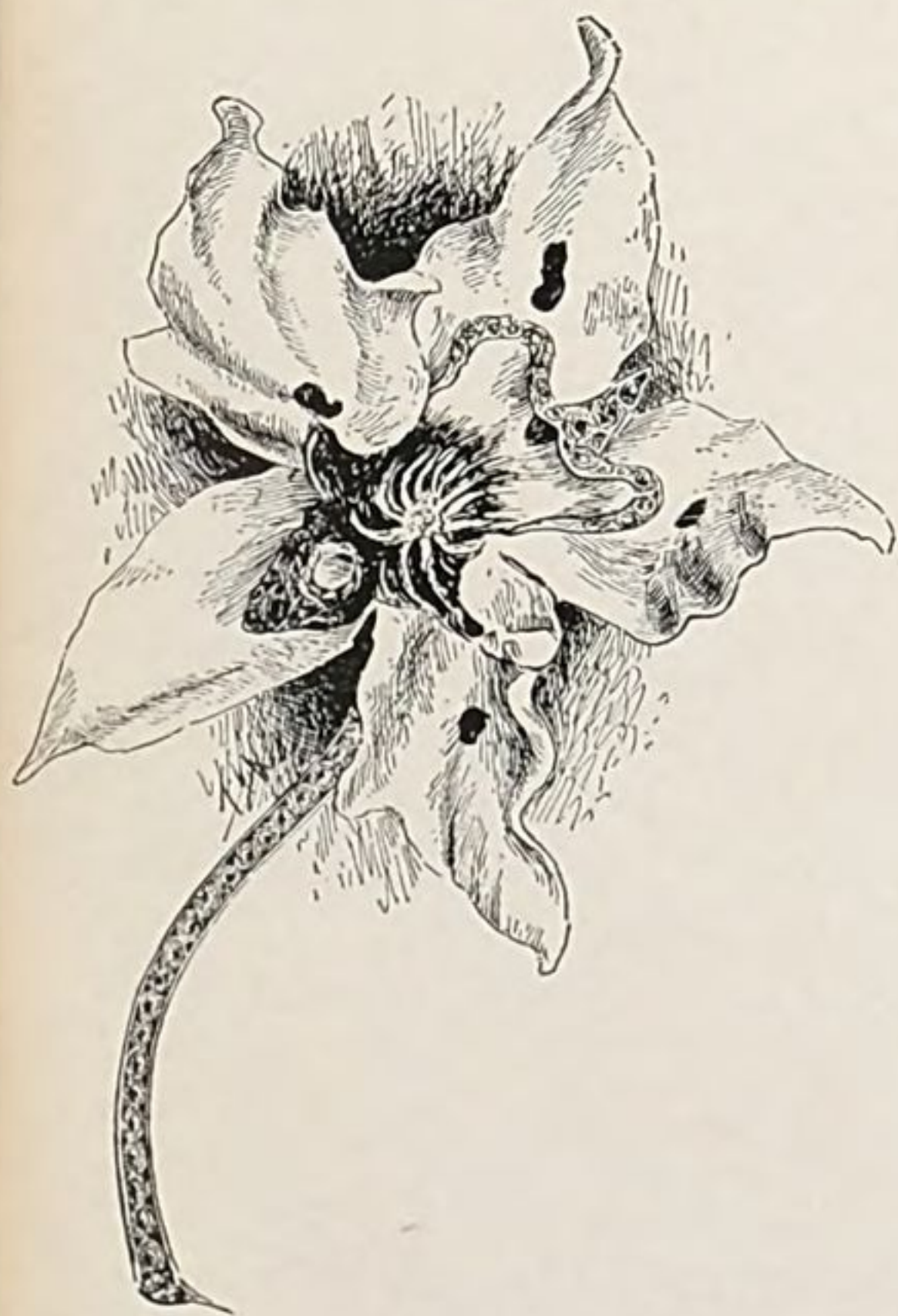
JEWELRY.

No. 16. PURSE RICHLY CHASED, GOLD MOUNTING.
Bead pouch with small American pearls woven together with small glass beads.



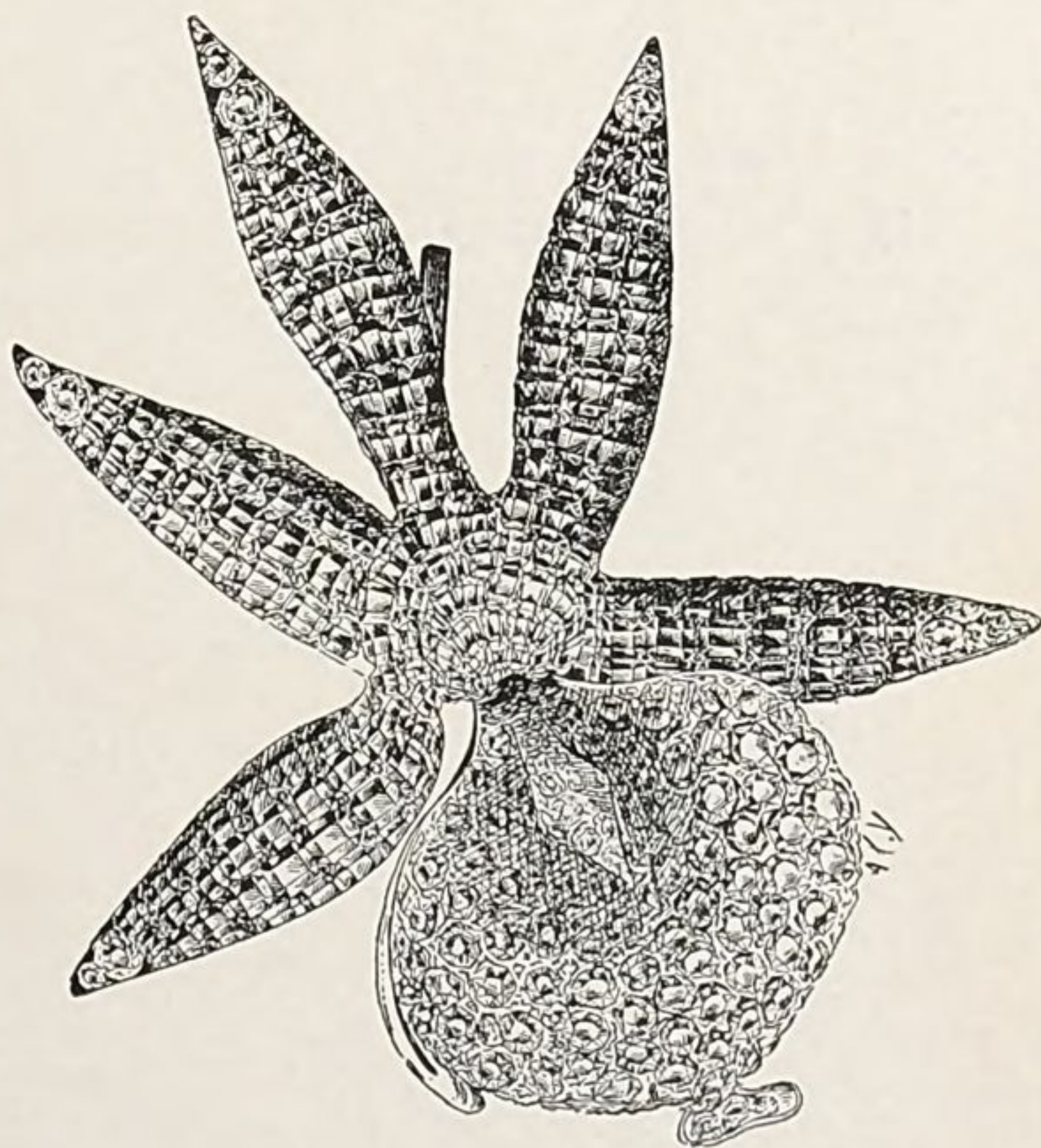
No. 17. ORCHID BROOCH—"CATTLEYA BICOLOR," BRAZIL.

Five brown leaves, delicate enamel purple center, border of brilliants, emerald and diamond stem.



No. 18. ORCHID BROOCH—ODONTOGLOSSUM ALEXANDRÆ CRISPINA, COLOMBIA.

Enamel delicate yellow with white and brown spots; lip yellow; border and stem diamonds.



No. 19. ORCHID BROOCH—ANGRÆCUM EBURNEUM, MADAGASCAR.

Five green gold leaves of pavé of emeralds, white gold lip pavé of diamonds, green calix.

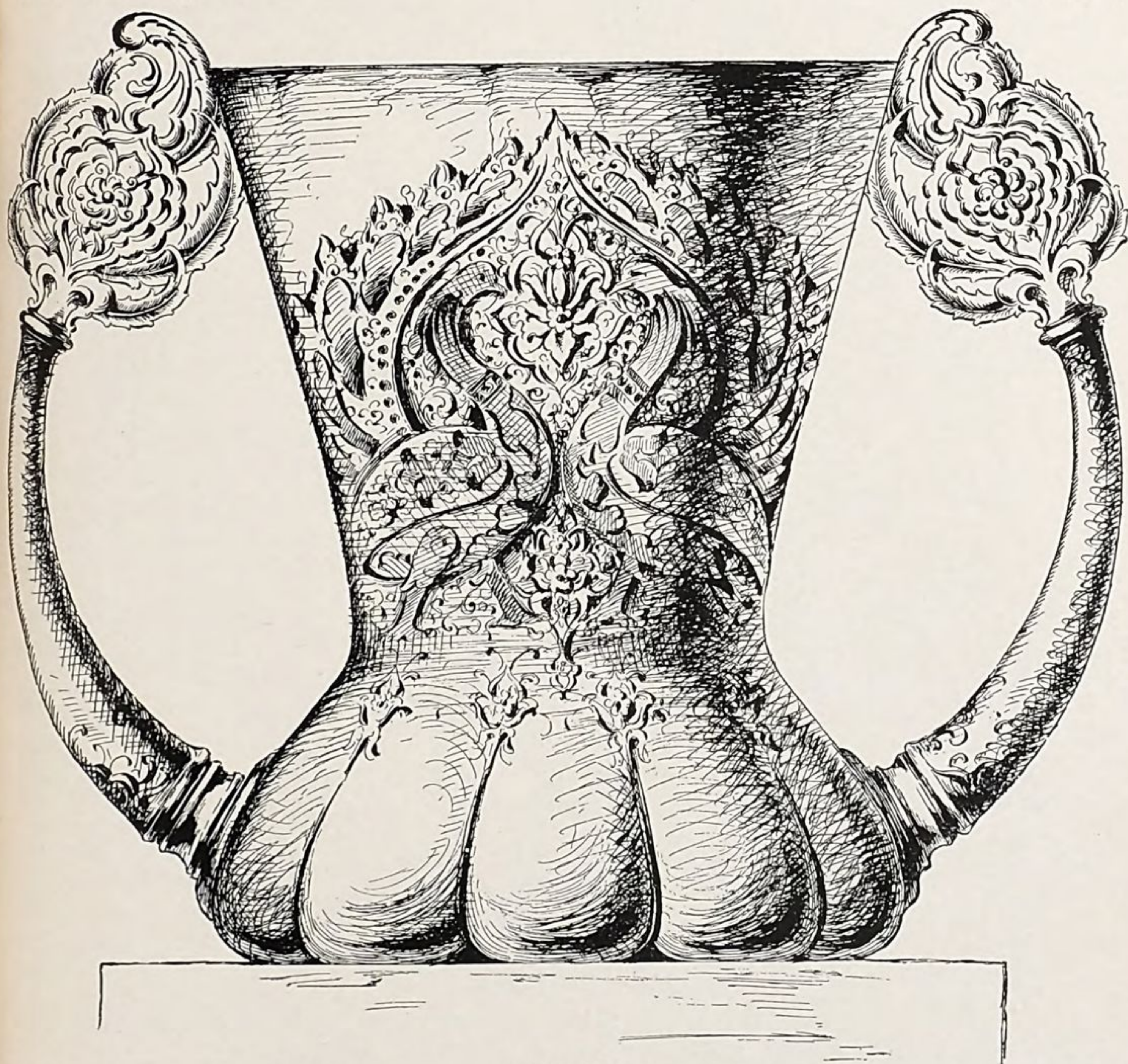
JEWELRY.



JEWELRY.

No. 20. SILVER WAITER.

Ciselure work, chased up from the front, not repoussé.



JEWELRY.

No. 21. SILVER LOVE CUP.
Repoussé, etched and inlaid with Niello.

MINERAL EXHIBITS

BY GEORGE F. KUNZ.

Fifty-five nations were represented at the Paris Exposition, and nearly every one of these had a governmental exhibit of the minerals of its country, besides in many cases collective exhibits of private collectors. Some of these exhibits were very remarkable, and had they been assembled in one building, as was the machinery in Machinery Hall, the mineralogical and metallurgical and precious stones exhibits would have been more impressive. As it was, they were scattered over such immense distances that important displays were often overlooked.

Class 41, which included minerals or, in other words, the products of mining and the materials obtained therefrom, contained over 1,800 distinct exhibits. A collection of gold shown in this class by a French engineer, in the French section, was perhaps the finest ever formed. It contained many remarkable specimens of gold from California; a wire of gold, 6 inches long, from Colorado; gold amalgam, nuggets, and gold dust. The three hundred specimens represented almost every gold-producing country in the world, and the collection was the result of over thirty years' work.

In the Liberal Arts section were remarkable exhibits of artificial minerals, exposed by M. Friedel of the École des Mines, and a collection by MM. Bourgeois and Gorgeu, formed from heated solution in glass tubes among which were artificial feldspar and other minerals never obtained by direct heating in a crucible.

Dr. Fouqué and Michel-Levy exhibited a magnificent series of rock-sections, as well as the colored plates illustrating their works on petrography. Dr. Fouqué also displayed specimens of the famous artificial, as well as the antique, Egyptian or Pompeian blue, from the ancient frescoes of Pompeii, which for a long time had been a puzzle to scientists, but which Dr. Fouqué demonstrated by analysis to be wollastonite; and the artificial product made by himself was fully equal to the original in beauty of color.

M. Etard exhibited beautiful groups of artificial argentite crystals.

In Class 15, instruments of precision were shown by M. J. Werlein. Microscopically prepared sections of orbicular diorite from Corsica, violane from the Pyrenees, granite and other rocks, in sections measuring four inches square and as thin as any microscopic section could be prepared. Also some beautifully prepared optical preparations of crystals of quartz, plates 4 inches long and about one one-hundredth of a millimetre in thickness, which had been cut parallel to the rhombohedral face and when punctured with a needle or sharp point would always separate into perfect rhombohedrons, showing that quartz, when properly prepared, has as perfect a cleavage as any mineral. Mineralogical and petrographical microscopes by MM. Nachet and Bertrand; goniometers by Fuess; the goniometers of the Mallard and Wyruboff, manufactured by Lutz, and the Dufet apparatus for measuring the angle of optical axes, manufactured by Ducretet.

In Class 18, Section of Decorative Arts, were some fine chandeliers of rock crystal, valued at \$7,000 each; pedestals covered with slabs of agate amethyst from Lorraine, valued at over \$2,000 a pair; rock-crystal spheres (not perfect however) up to $6\frac{1}{2}$ inches in diameter; and other magnificent examples of lapidarian work in agate, jasper, rhodonite, and jade.

From the Pyrenees and from Belgium, magnificent collections of finely colored marbles were shown.

Spain exhibited a large collection of apatite, transparent yellowish-green crystals, of the variety known as "asparagus stone," one inch in length, from the mines of Jumilia.

Servia sent a large series of the ores of mercury, among which were beautiful crystallized cinnabars, as well as the white crystals of chloride of mercury (calomel) from Mount Avala.

There was a series of interesting specimens illustrating the occurrence of ozokerite from the famous mines of Borislav, Galatia, which are still in active operation, notwithstanding the threatened competition of this same material from Utah.

The Russian exhibit contained a case of nephrite and graphite, exposed by M. Alibert, similar to the collections shown at the Exposition of 1867 and 1878, which were presented by M. Alibert to the École des Mines, the Musée Naturel, and the Conservatoire des Arts et Métiers. Jade was formerly obtained by M. Alibert in his graphite mines in Siberia, discovered in 1847 at Botougal in the Siam Mountains, near the Chinese frontier. One mass of jade from these mines weighs 1,300 pounds, another 1,100, and several of the specimens in the case weighed several hundred pounds each.

Of even more interest were the polished, transparent sections of boulders of jade, sawed by M. Alibert from blocks found by himself; these were beautifully polished on both sides, were less than one-eighth inch in thickness, and some measured three feet in length and

over eighteen inches in width, forming beautiful panes for windows having a delicate shading and brilliancy not to be obtained in any other mineral. With this was a large series of graphite, curiously carved into ornaments, to show the perfect homogeneity and fine grain of the graphite from his mines.

The collection of Mr. Woerfel contained a large number of table-tops, mantels, vases, and other ornaments of malachite, lapis lazuli, rhodonite, labrador spar, and other stones characteristically Russian, which have been used extensively in that country in the decoration of churches and palaces, and have been frequently made use of as imperial gifts by the Czar, as the royal palaces throughout Europe will testify.

From the Ural Mountains came an exhibit of a magnificent series of blue, white, and sherry-colored topaz crystals, some of the largest of which weighed one pound, and some smaller ones, several inches in length, were absolutely transparent; a doubly terminated crystal of beryl that weighed 1 pound 8 ounces, but was not entirely free from internal fractures; small crystals of alexandrite; some magnificent purple amethysts, unrivalled for depth and richness of color; chrome tourmaline in crystals from one to three inches in length; and other varieties of the well-known Russian minerals.

Paul de Kristoffowitch exhibited a very interesting material, termed by him pyrogranit, for which he has secured patent rights in many countries. It is obtained by vitrifying slates and shales and it imitates closely many varieties of marble, porphyry, and granite, having almost the hardness of the latter, and being susceptible of a high polish. It was shown as bath-tubs, tiles, and ornamental pieces, and is undoubtedly the most satisfactory of the artificial ornamental stones that have been produced.

The Russian Society for the mining of mercury, formed by Dr. Auerbach, the chemist, made a splendid exhibit of the ores and of native mercury from their mine. This mine was discovered by M. Minenkoff in 1879, but no development was attempted until 1886. The mine and the works are in central Russia, in the jurisdiction of Ekatherinoslaw, Bakmouth District, 4 kilometres east of the station Nikitowa on the Kursk-Karkoff-Azof Railroad. Besides the surface of cinnabar, covered with brilliant crystals, of special interest to the mineralogist were the quantities of perfectly detached crystals and penetration rhombohedral twins of cinnabar, which are quite unique; they measure from two to three millimetres across a face.

A notable feature in the Norwegian section was the exhibit of the famous Kongsberg silver mine in which were displayed ropes and wires of silver, some over 12 inches long, varying in thickness from that of a needle to more than an inch; these were interlaced, and in part attached to the rock. Of still more interest, however, was a perfect cube of native silver fully an inch in diameter, and some groups

of cube-octahedrons, measuring over half an inch in diameter, and covering surfaces over 4 inches square. Plans and diagrams of the mines accompanied this series.

Of considerable interest was a commercial exhibit of the minerals containing the rare earths, which in Norway are carefully preserved by the miners of feldspar, apatite, and quartz. The exhibit contained orangite, gadolinite, fergusonite, zircon, molybdenite, and other minerals, to be sold by the pound.

In the Hungarian section was a very interesting case of opals and also opal in the trachyte matrix, from the famous Hungarian mines of Czermowitza, which have been worked for over 300 years.

In the Roumanian section was exhibited a very interesting series of ambers, strikingly like those from Catania, Sicily, in form and in color; the different colors shown were light yellow, dark yellow, cloudy white, opaque white, black, brown, bluish-green, dark opalescent blue, and opaque red. This amber was all found in the department of Buzeo and in these places: Biscarusilei, Bisca-Chisjdului, Coltzia, Valea-boului, and Bodila. The Roumanian amber is exceedingly rare, and is very highly valued in Roumania.

Greece made a magnificent display from the famous mines at Laurium, which were worked before the beginning of the Christian era, as is proved beyond doubt by the fact, that, in the collection in the Assyrian gallery, in the Louvre, the writer saw necklaces made of beads of gold and carnelian, and also, to his surprise, of the blue and white veined beads of calamine from Laurium. Masses of this mineral were exhibited that must have weighed at least a ton each, and in the general exhibit were magnificent botryoidal specimens, from this locality, of the blue, green, and yellow calamine, which rivaled anything found elsewhere.

In the Persian section were shown masses of lapis lazuli, weighing several pounds each, and a large series of cut and engraved Persian turquoises.

In the Esplanade des Invalides, in the Palais Algérien, was an interesting collection of minerals from the province of Constantine, consisting of beautiful marbles, Algerian alabaster (an aragonite), concretions of phosphorite and calamine, and groups of senarmonite crystals.

In the Madagascar pavilion was exhibited a series of gravels containing sapphire, zircon, and tourmaline.

In the Japanese exhibit were beautiful crystals of colorless topaz.

A large and interesting collection of nickel ores, noumeeite, garnierite, etc., from New Caledonia, similar to those from our nickel mines at Riddle, Douglass County, Oregon.

In the New Zealand court were two large polished blocks of green oceanic jade, weighing 200 pounds each, and magnificent specimens of schaelite.

In the South African pavilion were exhibited from the new gold fields of South Africa, in a large safe, native gold valued at over \$60,000.

The Mexican exhibit was especially rich in its display of silver ores. Magnificent masses were covered with wire silver, and some lumps of amalgam weighed 20 pounds each. There were shown here splendid crystals of argentite, stephanite, pyrargyrite, also scalenohedral crystals of calcite, of the Iceland spar variety, over 6 inches long and 4 inches in diameter, covered with beautiful white crystals of stilbite, similar to that from Iceland. Magnificent veined blocks of so-called Mexican onyx came from Tecali, in the State of Puebla, and a large series of casts of Mexican meteorites, of many of which little is known outside of Mexico. These casts were presented to the Imperial Museum at Vienna.

In the elegant building of the Argentine Republic, the National Department of Mines of Buenos Ayres, Director-General H. D. Hoskold, had a collection of eighty flat cases, 25 by 35 inches. Among the more important exhibits were the large series of silver minerals from the Cerro Negro Mountains, in the province of Rioja, consisting almost entirely of native silver in limestone, frequently associated with zinc-blende, the silver either in wires, cubes, or veins, with cerargyrite and argentite. A mineral was also exhibited under the name of Argentarsenickel, claimed to be a new species, with the following analysis:

Silver.....	32.22	Sulphur.....	13.04
Zinc	6.60	Insoluble matter	2.66
Nickel	12.58	Moisture	0.34
Iron	8.40		
Manganese.....	0.70		100.00
Arsenic	23.46		

The ore of this district is exceedingly rich, and an assay gives 8,771 ounces of silver to the English ton. Among some specimens are also proustite and stephanite.

The Brazilian Commission exhibited a very interesting collection of the precious stones of Brazil, especially the diamond and its associations, but not such fine examples as those shown at our Centennial Exposition. Many of the fine specimens in this exhibit were loaned by European collectors and dealers. Among those of chief interest were a dish of yellow topaz crystals, several of which are over 2 inches in length and 1 inch in diameter; magnificent crystals of green tourmaline from 2½ to 4 inches long; fragments of crystals of amethyst 2 and 3 inches in diameter; diamond crystals from less than the size of a pin head up to 6 carats. There was also a collection of minerals associated with the diamond in Brazil, consisting of rutile, zircon, anatase, lazulite, and a set in miniature of the implements and bowls used in washing and in digging and working the river gravels. This entire case is the production of the province of Minas.

Of special interest are the "Sables Diamantifères," as the conglomerate rock containing the diamond is called, and also the masses of klaprothine, identical with the lazulite of Georgia, and the series of minerals of the gravels which were identified by Professor Gorceix, of the School of Mines, at Oura Preta, among which were pyrope, cyanite, pyrite, fibrolite, xenotime, anatase, hermatite, limonite, tourmaline, monazite, baierite (titanic iron), and itacolumite rock. These are especially interesting since they have all been found in North Carolina and Georgia. The Vicountess de Cavalcantie exhibited a case of jewels from the province of Minas, among which were some fine amethysts, topazes, aquamarines, citrines, and five beautiful examples of the chrysoberyl, or chrysolite jewelry worn and made in the latter part of the eighteenth century.

Among a remarkable series of ornaments made and worn by the Botocudo Indians of Brazil were some made of materials of marked mineralogical interest. The most notable were lip ornaments, one a rich Amazon-green feldspar, in the form of a disk, $2\frac{1}{2}$ inches in diameter and about 1 inch thick, with projecting shoulders for retaining the ornament in the lip. The great breadth of this would suggest difficulty in the use of a pipe, but Dr. Ladislaus Netto, Director of the National Museum, Rio de Janeiro, exhibited a pipe used by the Indians adapted to overcome this difficulty. The stem was flat and over 2 inches in diameter, and quite thin, so that it could be laid on the projecting lip ornament and easily held in the mouth. Another lip ornament was 3 inches long and an inch and a half wide; another an oval disk, $3\frac{1}{2}$ inches long and 1 inch thick, of beryl; a flat, sole-like fish, 2 inches long and 1 inch wide, made of a material said to be jade; a circular shaft of rock crystal, 5 inches long, with two projecting ends; two spear heads, 3 and 4 inches long, and some ear ornaments, all made of transparent rock crystal.

Undoubtedly the richest mineral exhibit at the Exposition was that in the Bolivian pavilion. The famous Huanchaca Company reproduced a gallery of the Pulacayo mine. This gallery, which served as a rear entrance to the building, was 20 feet long and $7\frac{1}{2}$ feet high, and contained 60,000 pounds of ore, valued at 170,000 francs. Bars and ingots of silver, valued at over 300,000 francs, were exhibited by the company.

From the mines of Corocoro a magnificent exhibit of crystallized native copper, in the form of radiating, arborescent sheets.

A remarkable exhibit of the native bismuth was made by the Aramayo Company from Tupiza Sanyreey Muerte a Tasna, containing some of the most magnificent specimens of native bismuth probably ever seen. One of these was a brilliant cleavage mass, covered with crystals more than 2 inches across and weighing at least 4 kilos. There were also magnificent masses of carbonate of bismuth—valentinite—in orthorhombic prisms, 3 inches long.

In the Bolivian pavilion was also a series of specimens of lapis lazuli from the Andes, to which were given four distinct names, *i. e.*, *Lapis agatado*, *Lapis lazuli*, *Lapis maclado*, and *Lapis laminosa*. Peculiarly interesting also were the large masses of talcose slate, filled with hexagonal crystals of aragonite and of hexagonal pseudomorphs of native copper, replacing aragonite.

The Colquechaca Company exhibited a specimen of botryoidal arsenic, covered with crystals of proustite, measuring 25 by 20 inches, and weighing 320 pounds; also a quantity of smaller specimens, with the proustite in fine crystals.

The Company Itos had a large exhibit of silver minerals and fine specimens of proustite. Portions of wall rock a foot square were covered with beautiful acicular crystals of jamesonite, matted like mineral wool, and an inch thick. These were as fine as anything ever found.

An interesting series of silver minerals was exhibited by the famous silver mines of Potosi, which are situated at an altitude of 14,000 feet above the level of the sea. History tells us, that the Spaniards obtained from these mines, since the beginning of the sixteenth century, \$2,000,000,000 worth of silver by the sacrifice of the lives of millions of natives, who, when once set at work in the mines rarely returned to their homes.

The Chilean court contained a collection of four hundred specimens, a very complete metallurgical rather than a mineralogical exhibit of the gold, silver, copper, zinc, and lead from Chili. Among the few specimens of mineralogical interest were two beautiful groups of proustite (ruby silver), from Caracoles, and a fine display of nitrate of soda from Tarapaca.

The Paraguayan Republic showed little else than some handsome marbles and specimens of rock and refined salt.

Among the forty-four exhibits from Salvador may be mentioned native platinum, iron pyrites, jasper, and porphyry.

The United States exhibit of minerals was prepared by Prof. William P. Blake and was under my charge at the exposition. It was not intended to be a complete collection of American minerals, but rather such a representative series as could be gathered in the short time allotted to its formation. Among the exhibits may be mentioned that of the famous Anaconda Mining Company, containing a set of specimens forming a series of the ore, concentrates, and matte of that great copper mine. Professor Blake exhibited a crystal of columbite, the size of a man's hand, from the Black Hills; the Copper Basin Mining Company had a fine series of malachite and azurite in the sandstone conglomerate, from Copper Basin, Prescott, Yavapai County, Arizona; from Harney Peak, Black Hills, Dakota, were several tons of vein rock illustrating the occurrence of cassiterite; from the New Almaden quicksilver mines, California, a case

of fine specimens of cinnabar and bitumen associated with native mercury. Besides these there were seventy-five minor exhibits. In this section also, was the collection of minerals, partly American, exhibited by Prof. A. E. Foote, and a large display of agatized trunks and sections of trees, with polished sides, of the jasperized and agatized wood from the Drake Company, of Arizona, to whom was awarded a gold medal.

The State of Nevada exhibited a collection of ores and minerals made by the State mineralogist, Dr. J. M. Biber, representing the mineral deposits of the State.

Tiffany & Co. of New York had a beautiful exhibit of minerals and semi-gems, a choice collection of crystallized specimens from the United States.

The exhibit of tourmalines of the Mount Mica Company, of Maine, were from the celebrated mineral deposit at Paris, Maine, and comprised ten cut specimens from 3 to 13 carats in weight and exhibiting a variety of color, white, light green, grass green, dark green, deep blue green, chrysoberyl green, yellow green, light red, carmine red, garnet red, etc. The locality was discovered by Elijah L. Hamlin in 1820, and has yielded a great number of tourmalines of various hues and some of the most remarkable and valuable crystals of tourmaline known, even 6 to 8 inches in length, some of them exhibiting the hues of green, pink, white, and blue in the same crystal.

FIFTH GROUP.

EXTRACTIVE ARTS—RAW AND MANUFACTURED
PRODUCTS.

[EXTRACT FROM THE OFFICIAL CLASSIFICATION.]

FIFTH GROUP.

EXTRACTIVE ARTS—RAW AND MANUFACTURED PRODUCTS.

CLASS 41. Products of mining and metallurgy.

CLASS 42. Products of forest growth and forest industries.

CLASS 43. Products of hunting. Products of fisheries. Apparatus and instruments for fishing, and for gathering fruits of natural growth.

CLASS 44. Agricultural products not used for food.

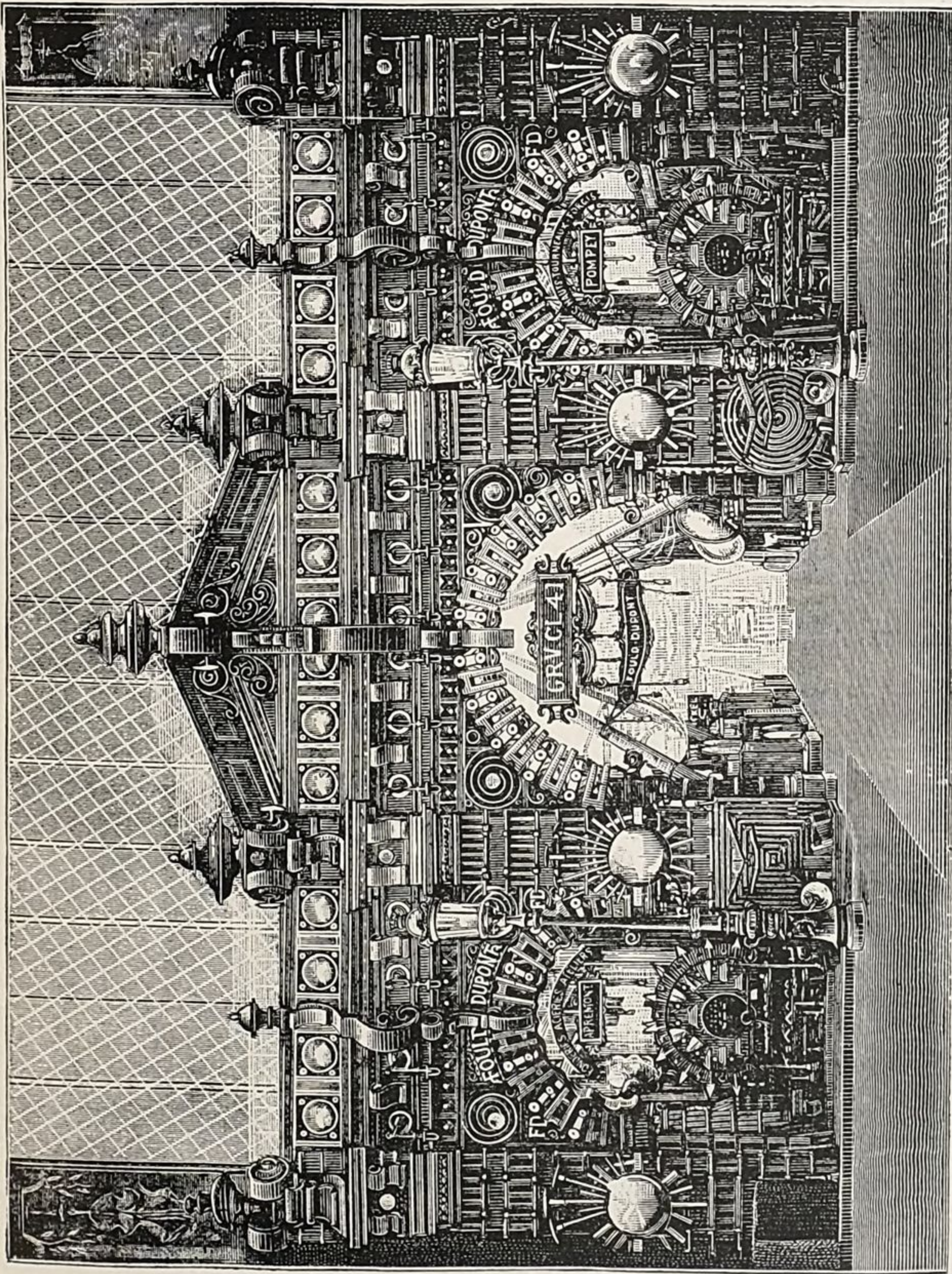
CLASS 45. Chemical and pharmaceutical products.

CLASS 46. Chemical methods of bleaching, dyeing, printing, and finishing.

CLASS 47. Leather and skins.

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FACADE OF CLASS 41—EXHIBIT OF FOULD-DUPONT.

[See page 419.]

PRODUCTS OF MINING AND METALLURGY.

By W. H. CHANDLER, Ph. D.

CLASS 41.—*PRODUCTS OF MINING AND METALLURGY.*

There were 1,285 exhibitors in this class, and of these 53 received grand prizes and 191 received gold medals. Germany, one of the large iron-producing countries, was not represented.

The production of coal, iron, and zinc in 1876 and 1888 is given in the tables, as well as the production of some other metals. The great increase in the production by the United States has changed the relative positions of the metal-producing countries.

In the preparation of fuel there are various improved forms of coke ovens, utilizing the gases and condensing the useful by-products hitherto wasted. The collection of similar by-products in the blast furnace gases has also been accomplished. In iron metallurgy neutral and basic lining in the open-hearth furnace for the treatment of phosphoric pig is coming somewhat into use.

In metallurgic processes the most important is the basic Bessemer or Thomas-Gilchrist process, the first patent being dated 1878. In copper, the Manhès process by use of a converter dates from 1880; this idea was not new, as the writer remembers to have heard that the president of one of the copper smelting companies had filed a caveat for the use of the Bessemer process for refining copper mattes soon after the introduction of that process. In the metallurgy of zinc, the heating of the muffles for the production of spelter by gas and the regenerative system has come into use to some extent. With aluminium the greatest progress has been made by Americans, the Castner and Hall processes and the Cowles electric furnace being the inventions of our countrymen. The latter is the first successful application of electricity for furnace work. The application of electricity to the reduction of aluminium (Hall's patent) and to welding of metals (Thompson's patent) are also American inventions.

We note the large number of metallic alloys in use in the arts and the great progress in tempering and annealing. The studies of scientists on the structure and physical properties of metals have contributed not a little to the progress of metallurgy.

In this report, those processes and products are discussed which have made noteworthy progress since the Exposition of 1878.

Number of exhibitors and prizes awarded in Class 41.

Country.	Grand prizes.	Gold medals.	Exhibitors.	Country.	Grand prizes.	Gold medals.	Exhibitors.
Alsace Lorraine.....	1	.....	1	Japan.....	.....	.....	6
Argentine Republic....	1	1	15	Luxembourg.....	1	.....	3
Austria-Hungary.....	.....	1	5	Mexico.....	2	9	25
Belgium.....	5	20	97	Nicaragua.....	.....	1	1
Bolivia.....	1	5	48	Norway.....	.....	2	19
Brazil.....	2	4	35	Paraguay.....	.....	.....	1
Chili.....	1	2	6	Portugal.....	1	3	12
Colombia.....	.....	1	1	Roumania.....	.....	1	20
Domingo.....	.....	1	12	Russia.....	1	12	50
Egypt.....	.....	.....	1	San Marin.....	.....	.....	4
Ecuador.....	.....	.....	5	Salvador.....	.....	1	46
France.....	24	72	411	Servia.....	.....	1	24
French colonies.....	1	6	136	Siam.....	.....	1	1
Guatemala.....	.....	1	30	South Africa Republic	1	1	6
Great Britain.....	3	20	59	Spain.....	1	2	27
G. B. Colonies.....	4	6	12	Sweden.....	.....	.....	1
Greece.....	.....	3	20	Switzerland.....	6	2	16
Hawaii.....	.....	.....	1	United States.....	1	8	83
Holland.....	.....	.....	6	Uruguay.....	.....	.....	7
Honduras.....	.....	1	1	Venezuela.....	1	1	19
Italy.....	1	2	13	Total.....	53	191	1,285

Production of coal, iron ore, pig iron, and steel, in tons.

Country.	Coal.		Iron ore.		Pig iron.		Steel.	
	1876.	1888.	1876.	1888.	1876.	1888.	1876.	1888.
Great Britain....	185,477,282	169,935,219	17,111,049	14,590,713	6,642,895	7,998,969	545,560	3,734,130
Germany.....	*43,451,371	81,960,000	*2,072,250	10,664,800	*1,324,338	4,337,121	*126,500	1,862,000
United States....	41,000,000	123,674,774	4,500,000	7,648,726	2,093,236	7,268,507	525,596	2,899,440
France.....	17,047,762	22,602,874	3,081,026	2,500,000	1,449,537	1,683,349	254,191	517,294
Belgium.....	14,329,578	19,218,484	269,206	†213,000	490,498	826,984	75,258	231,000
Austria.....	11,867,715	24,000,000	554,965	2,200,000	273,045	761,606	.....	355,038
Russia.....	1,708,512	†4,464,174	1,935,187	†1,334,000	427,588	†532,649	3,945	†222,025
Spain.....	101,522	†1,000,000	436,586	4,500,000	56,462	200,000	2,720	114,537
Sweden.....	96,674	†300,000	787,092	939,540	348,257	457,052	18,785	†24,500
Luxembourg.....	.....	(§)	1,196,729	(§)	280,500	(§)	.....	.....
Italy.....	.....	327,665	.....	230,575	.....	12,265	.....	†73,262

* Prussia only. † 1889. ‡ 1887. § With Germany.

Production of zinc, in tons.

Country.	1876.	1888.	Country.	1876.	1888.
Austria.....	3,979	3,827	Prussia.....	83,634	83,375
Belgium.....	49,960	133,245	Russia.....	3,990	3,785
France.....	17,434	16,140	Spain.....	2,940	(*)
Great Britain..	6,747	26,633	United States..	16,091	49,922

* With France.

Production of copper, in tons.

Country.	1879.	1888.	Country.	1879.	1888.
Africa	4,828	7,550	Japan	3,900	11,000
Australia	9,500	7,450	Mexico.....	400	2,766
Austria	1,269	1,868	Norway and Sweden.....	3,212	2,470
Canada.....	1,550	4,300	Russia.....	3,081	4,700
Chili	49,318	31,240	South America (except Chili).	4,497	5,850
England.....	3,462	1,500	Spain and Portugal.....	32,697	60,300
Germany	9,005	15,230	United States.....	23,000	103,128
Italy	1,140	2,500	Total	150,859	261,852

Production of lead in United States.

	Tons.
1876	64,070
1888	186,000
1889	190,000

The production of other metals in the United States was: Mercury, 1887, 33,825; 1888, 33,250 flasks of 76½ pounds each; antimony, 1887, 75 tons of 2,000 pounds; platinum, 1887, 448 Troy ounces; nickel, 1887, 205,556 pounds.

In 1886 Russia produced 138,792 Troy ounces of platinum.

Gold and silver production.

Year.	Gold.		Fine Silver (Troy ounces).	
	World.	United States.	World.	United States.
1877	\$113,947,178	\$46,897,390	69,913,712	30,777,870
1888.....	109,928,000	33,175,000	110,086,453	45,792,081
1889.....	118,832,000	32,800,000	126,000,000	50,008,875

Mineral products of the United States.

	1882.	1888.
Metallic products.....	\$228,410,380	\$256,245,403
Nonmetallic products.....	219,755,109	328,914,518
Unspecified mineral products.....	8,000,000	6,500,000
	456,165,489	591,659,921

COAL.

COKE OVENS FOR PRESERVATION OF AMMONIA AND TAR.

These ovens have come considerably into use in England, and especially in Germany. In France they are in use at a few collieries, but their use here does not seem to be extending. In Germany, however, the number is increasing. In the United States very little has been done in this direction.

There are many forms and modifications of ovens and their accessories. In England the Carves and Simon-Carves ovens are used, as well as in France. In Germany the Hoffman and the Hoffman-Otto are used, and the older forms of ovens have been adapted and altered in order to utilize the gases given off during coking, for the purpose of heating the ovens and for the recovery of the tar and ammonia.

JAMESON OVEN.

In these the gases are withdrawn in a beehive oven through a hollow floor.

Some experiments made with similar ovens at the Calumet Iron and Steel Works by the National Coke and Fuel Company, of Chicago, are said to have yielded 15,000 cubic feet of gas, 365 gallons of coal oil, and 3 pounds of sulphate of ammonia from a ton of coal.

The gases are withdrawn about 10 inches above the surface level of the charge of coal, opposite the charging door. The tar is said to contain phenols and paraffine, but is deficient in benzole.

CARVES COKE OVENS.

These are rectangular ovens built in block, with bottom and side flues. The gases are withdrawn at the top, and, after passing through the condensers, by means of an exhaust, forced into the lower flues, together with a current of cold air for its combustion.

SIMON-CARVES COKE OVEN.

In these the air is previously heated to 500° or 600° C., by passing through flues in contact with hot flues conveying away the spent fire-gases from the flues of the ovens. The amount of coke obtained is 75 tons against 63 by the beehive ovens. The quantity of tar is about 5 gallons per ton of coal. At the Terrenoire Works in France, the gases, after being deprived of the tar and ammonia, are passed through scrubbers, consisting of upright cylinders filled with pebbles, over which trickles the heavy oil obtained from the distillation of the tar. By this means a quantity of benzole is separated from the gases; from the scrubbers the gases pass through washing boxes bubbling

through heavy oil and dissolving still more benzole. Five and one-half pounds of benzole per ton of coal has been obtained.

	Analysis of tars from—	
	Carves ovens.*	Simon- Carves ovens.†
	<i>Per cent.</i>	<i>Per cent.</i>
Light oils.....	4.50	5.12
Creosote oils.....	20.40	7.44
Anthracene oils.....	34.20	34.03
Naphtha.....		3.05
Pitch.....		45.17

*Analysis by Watson and Sadler.

†Analysis by Ernest Wirth.

Further treatment of distillate gave—

[Per cent. on tar.]

Water	10.00	.....
Fifty per cent. benzole.	0.50	0.703
Solvent naphtha, 90 per cent.....	0.60	1.031
Heavy naphtha.....	0.40	*0.434
Crude carbolic acid.....	0.05	0.305
Creosote oil.....	46.50	†0.352
Anthracene	0.74	2.396
Pitch and loss.....	41.21	.....
	100.00	

* Burning naphtha, 30 per cent.

† Cresote, crude.

One ton of tar yields 1.44 gallons 50 per cent. benzole and 48.2 pounds of 28 per cent. anthracene.

The cost of the Simon-Carves ovens in England has been given at £200, against £56 for a common beehive oven.

THE HOFFMAN COKE OVENS.

These ovens make use of the Siemens regenerators, the ovens being built in a block and the regenerators being long flues filled with fire bricks in the usual way, extending below the whole row of ovens on either end, thus constituting two continuous regenerators which communicate at one end with the chimney. Beneath each oven is a bottom flue which is divided by a cross partition into two equal lengths which communicate with the regenerator on its respective side. The bottom flue also is connected with perpendicular flues placed in the side walls of the oven above, which discharge into an upper flue, running the whole length of the wall. A large gas pipe

is placed outside the ovens, extending the whole length of the block on both sides, which discharges the gas into the bottom flues by means of branch pipes and valves.

The gas given off by the coking of the coal is withdrawn from the ovens through openings in the top of each oven, and passes into a common main to the coolers and washers, for the removal of the ammonia and tar, a fan exhaust being placed beyond the washers. The same fan forces the gas to the gas mains at the ovens, and at the same time another fan forces air through the regenerators on one or the other side of the block of ovens. The gas and heated air meeting in the bottom flues combustion ensues there and in the side flues, the gases passing upward through half the flues of each oven and downward through the other half, thence through the other regenerator to the chimney. At the proper interval, about an hour, the valves are reversed and the current of gases pass in the opposite direction, the air being heated in the other regenerator. The wall partitions of the side flue are $3\frac{1}{2}$ inches thick. The temperature of the air is $1,800^{\circ}$ F., and there is generally a surplus of gas. A charge of 5 tons 13 cwt. of coal requires about 48 hours for coking. The coke is equal in quality to that obtained from ordinary ovens. The yield is several per cent. higher, owing to the airtightness of the openings for charging the coal and discharging the coke and to a slight pressure of gas in the ovens.

Temperatures.—Bottom flue, $2,200^{\circ}$ to $2,550^{\circ}$ F. Side flue, $2,000^{\circ}$ to $2,200^{\circ}$ F. Regenerators, when air first admitted $1,800^{\circ}$, an hour afterward $1,330^{\circ}$. In the chimney 800° to 932° .

The coolers, through which the gas from the ovens first passes, consist of vertical iron cylinders containing vertical iron tubes, water passing through the tubes and the gas in the opposite direction outside them. The gas in the rising tubes from the ovens $1,200^{\circ}$ to $1,300^{\circ}$, in the common main 400° to 750° , before the coolers 170° to 250° , beyond the coolers 65° to 85° . The washers through which the gas next passes are vertical iron cylinders containing a great number of perforated plates placed horizontally over one another. Water trickles downward and washes the gas passing upward. Here will be deposited the tar and ammonia not condensed in the coolers. Temperature of the water 55° F. The cooling surface of the coolers is 5.72 square feet and of the washers 7.8 square feet per 1,000 feet of gas.

The yield of ammonia, estimated as sulphate of ammonia, is 1 per cent. of the weight of coal, and of tar 3 per cent., varying of course with the nature of the coal. The tar contains less benzole and an equal amount of naphthaline and anthracene as coal tar from gas works.

Analysis of the gas.

	Per cent.
Ethene	1.63
Methene	36.11
Hydrogen	53.32
Carbonic oxide.....	1.41
Carbonic acid.....	6.49
Sulphureted hydrogen.....	0.43
Benzole vapor	0.61
	100.00

Production of gas per coke oven, per day, 24,700 cubic feet; required for coking process, 17,700; surplus, 7,000 cubic feet, which can be used for heating the boilers.

Analysis of tar from Hoffman-Otto coke ovens, by G. Lunge.

	Per cent.
Aniline benzole.....	1.68
Crude naphthaline	7.69
Crude phenols	2.23
Anthracene, 33 per cent.....	1.50
Creosote oil.....	8.24
Anthracene oil.....	42.76
Pitch	30.55
Water .....	.....
	98.38

Equal in volume to best description of tar from gas works.

RECOVERING OF TAR AND AMMONIA FROM BLAST FURNACE GASES.

The firm of William Baird & Co., of Scotland, have adopted the Alexander & McCosh process, the coal used being a splint coal and used raw. The gases of eight blast furnaces are collected and passed through an atmospheric condenser similar to those used in ordinary gas works, 200 iron tubes, 40 feet long, 2½ feet in diameter. The gases upon entering have a temperature of 300° to 400° F. and on leaving 120° F. They then pass through the water condenser, 45 by 18 by 45 feet, iron tubes surrounded by water, and are reduced in temperature to 60° to 70° F. In these two condensers there are 2¼ square feet of cooling surface to every 1,000 cubic feet of gas per 24 hours, 30 gallons of water to the ton of coal are condensed here from the gases, but the amount of tar is small. From here the gases pass to the scrubber, 80 by 25 by 25 feet, containing twenty-nine perforated diaphragms, set at an angle. The wash water trickles downward through the scrubber. The gases pass through a second scrubber, 60 by 20 by 20 feet. The liquor of the second scrubber is run back to the first scrubber, and worked up at 2.5°, Twaddell.

In the gases leaving the first scrubber is ammonia equal to 2 pounds sulphate per ton of coal and in the exit gases from the second scrub-

ber 2 to 3 ounces per ton or to 125,000 cubic feet of gas. There is in all 5 to $7\frac{1}{2}$ pounds of ammonia in 125,000 cubic feet of gas.

There are three sets of Roots' blowers. The ammoniacal liquor is boiled off in six large boilers, 9 feet diameter and 30 feet long, heated by the waste gases. The liquor flows from one to the other, in the last one lime is introduced to set free the fixed ammonia. The ammonia given off is conducted into oil of vitriol held in saturators, round iron tanks lined with lead. The saturated liquor is evaporated in iron boxes lined with lead, and heated by lead steam pipes. The crystals of sulphate of ammonia are ladled out of these evaporators.

The tar is distilled in six stills, holding altogether 10,000 gallons. The yield is 50 to 60 parts water, 15 to 20 oil, and the rest pitch. The yield of sulphate of ammonia is 22 to 23 pounds per ton of coal and 40 gallons of crude tar or 16 gallons of boiled tar.

The Dempster & Henderson processes vary in construction of the apparatus from the foregoing, the cost of the former is £6,000 per furnace, and of the latter £5,000 per furnace.

• In the Addie process at the Langloan Works, the gases are mixed with sulphurous acid gas to combine with the ammonia as sulphite; the sulphurous acid gas is produced by the combustion of waste materials containing sulphur. The mixed gas passes through two scrubbers, entering the first at 500° F. and leaving the second at 140° F. The sulphite of ammonia liquor is concentrated, decomposed with lime, and allowed to fall through a tower with diaphragms. An upward current of superheated steam at 800° F. expels the ammonia, which is conducted to saturators, lead-lined boxes 6 by $5\frac{1}{2}$ by 3 feet. The saturated acid is settled and boiled down as usual.

The Neilson process, in use at the Summerlee Works, absorbs the ammonia in dilute sulphuric acid in the second scrubber, the gases entering the first scrubber at 500° F. and the second at 140° F. From four furnaces, consuming 300 tons of coal per 24 hours, the plant for this process would cost £8,500, and turn out 25 pounds of sulphate of ammonia per ton of coal. The make of tar is less than by the condensation processes, which produce 50 per cent. more.

The composition of these tars varies with the process; the hot or acid processes give tars of a higher specific gravity and containing only the higher burning oils. The specific gravity is as high as 1.09. They contain less oil and more pitch than the tar from the condensation and cooling processes. Twenty to 25 per cent. of oil is obtained from the boiled tar of the hot process and 30 to 42 per cent. from the cool process. Creosote oils from the hot process contained 20 to 25 per cent. of phenols and that from the cool process 20 to 40 per cent. The light oil contains paraffine, basic bodies, and phenols.

IRON.

PERCY C. GILCHRIST, LONDON, ENGLAND.

Raw and finished material to illustrate the basic or Thomas-Gilchrist process. This exhibitor received a grand prize.

These are exhibits of the Thomas & Gilchrist process for the dephosphorization of iron and the production of steel. This is called in some countries Thomas iron. G. J. Snelus proposed the name "basic process." It is also called "Basic Bessemer process."

Mr. Grunner first clearly discussed the condition necessary for the dephosphorization of pig-iron in 1867. In 1869 magnesian bricks were tried on a small scale by a Parisian engineer, and two patents for dephosphorization by basic linings in converters and open hearth were taken out. In 1872 G. J. Snelus, of England, took out a patent for lining of cupolas, furnaces, Bessemer converters, etc., composed of lime or limestone, wholly calcic or magnesian, and burned at the highest possible temperature. In 1878 S. G. Thomas, of England, obtained a patent for the addition of basic material, such as lime, lime and magnesia or lime and iron ore, to melted pig-iron contained in a Bessemer converter or open hearth furnace, with a calcareous or magnesian lining. The quantity of such addition is five times the phosphorus and silicon in the charge.

In 1879 the same person obtained a patent for blowing the melted metal in the converter, lined with basic material and containing basic material, for from 1 to 6 minutes after the disappearance of the carbon lines and until the chimney emits copious brown smoke and the flame is edged with white smoke. In the same year the same person obtained a patent for the use of a mixture of lime or magnesian lime and tar or tar and creosote, for the manufacture of refractory bricks and furnace linings. Thomas obtained a patent in 1879 for first refining the metal in a fixed Bessemer converter with a siliceous lining and then finishing the refining in a basic converter. The silicon would be taken out in the first and the phosphorus in the last.

In 1878 Edward Riley, of England, obtained a patent for the use of a mixture of lime and petroleum and similar oils. He mentions tar, but does not claim it.

These patents are the controlling patents of the basic Bessemer process of the present time.

Jacob Reese, of Pittsburgh, Pennsylvania, has obtained patents which are said to interfere with these in certain particulars. He also has some patents which supplement these in the process, under certain conditions. In 1883 he obtained a patent for the addition of phosphoric slag from the basic converter to the blast furnace, to

increase the phosphorus in basic Bessemer pig iron when the ores did not contain sufficient phosphorus. In the same year another patent for supplying the exact amount of air necessary to the after blow. In the same year another patent for utilizing forge cinder containing phosphorus. In the same year, for the combination of a basic converter and an acid open-hearth furnace for the making of high carbon steel for high phosphoric pig-iron, which is difficult to accomplish by the basic converter. In 1889, for the combination of the acid Bessemer converter and the basic open-hearth furnace. This process would be useful with ores rich in silicon and phosphorus.

The basic lining of the converters is composed of basic brick of newly burnt lime, or magnesian lime better, and coal tar, a limestone containing 6 per cent. silica, 2 per cent. alumina, 1.5 per cent. oxide of iron, and magnesia being to the lime in the proportion of 2 to 3. The calcination of the limestone should be conducted at a very high heat. The calcined limestone is mixed with the tar, warm, in a mortar mill, 6 to 17 per cent. of tar being used. To make bricks or Bessemer tuyères in molds with great pressure, 6 to 10 per cent. is sufficient. The bricks are burnt in kilns at a very high temperature. The bricks are set in the converter with a similar mixture of calcined limestone and tar as a cement. When the mixture, instead of the bricks, is used for ramming the linings, 10 per cent. of tar is sufficient.

The tuyères are made as above or the bottoms are rammed with the mixture around iron rods, the withdrawal of which leaves the openings for the blast. The repairs are performed by liquid lime-tar without cooling the converters. In regard to the durability of the linings it is stated that more or less extensive repairs are necessary after an average of fifty-six blows. The bottoms last an average of fourteen blows. The consumption of basic material is 48 kilos per 1,000 kilos of steel. In the acid process the consumption of ganister and tuyères is 40 kilos.

The converter is heated up with coke and lime mixed with small coal added. This is blown for a few minutes to heat up the lime. An average of 15 per cent. of lime on the steel produced is used. The metal is then run in and the blowing continued up to the vanishing point of the carbon lines of the spectrum and an after blow until a copious brown smoke is emitted from the converter and a white smoke around the edge of the flame. The duration of the whole blow is from 12 to 25 minutes. A test piece is taken shortly before the blow is finished; this is flattened hot under the hammer, chilled in water, and broken. If the metal is hard and has the characteristic appearance of phosphorus, the blow is continued for the period dictated by experience. A second test is rarely taken. The slag is run off and the spiegeleisen added. This running off of the slag prevents the reduction of the slag by the addition of the spie-

geleisen. Another method is to pour half the metal into the ladle, then add a quantity of Bessemer pig to reduce oxide of iron and get rid of gases, then the remainder of the metal is poured and the spiegeleisen added. The length of the first blow varies, as given by one authority, from 9 to 13 minutes and of the after blow 2 to 3½ minutes. The number of blows in 24 hours is generally considerably less than with the acid process, though some German work claims equal production. The loss of metal is given an average of 15 per cent. against 12 per cent. in the acid process.

The metal is applied to most of the purposes for which metal for the acid process is used. The slag contains from 17 to 20 per cent. phosphoric acid, and 50 per cent. lime and is used for agricultural purposes.

Order of elimination of impurities from iron.

Acid lined converter.	Basic lined converter.
1. Silicon.	1. Silicon.
2. Carbon.	2. Carbon.
3. Manganese.	3. Phosphorus.
4. Iron.	4. Manganese.
(not eliminated)	5. Sulphur.
Sulphur.	6. Iron.
Phosphorus.	

A diagram in a paper by J. Massenez, before the Iron and Steel Institute, illustrates the elimination of impurities in a basic blow:

Carbon quite steadily was consumed by the ninth minute. Silicon rapidly was consumed by the second minute. Phosphorus slightly consumed till the ninth minute, then rapidly by 11½ minutes. Manganese gradually consumed by 11½ minutes. Sulphur increases slightly to the ninth minute, by 11½ minutes disappears.

	Charge.	11½ Minutes.	Steel.
Silicon	0.83	Trace.	Trace.
Carbon	3.05	0.12	0.24
Phosphorus.....	1.37	0.04	0.03
Manganese	0.41	0.07	0.36
Sulphur.....	0.33	0.18	0.12

These analyses are given simply to illustrate the above-mentioned diagram and not as an average example of the process. Whereas in the acid Bessemer process the heat is furnished chiefly by the oxidation of the silicon, in the basic Bessemer process the heat is furnished largely by the combustion of the phosphorus, which enters into combination with the basic materials and passes off in the slag.

Prof. W. B. Philips states that since 1878, when this process was first started, including 1888, there has been produced more than 8,000,000 tons of basic Bessemer steel, of which scarcely 50,000 tons have been produced in the United States, while now it is not made at all there.

A suitable pig-iron for this process contains, carbon, 2.5 to 3.1; phosphorus, 2 to 3; sulphur, 0.6 upper limit; silicon, 1.5 upper limit; manganese, 1 to 3.

It is difficult to find suitable ore for this pig-iron; the most favorable outlook is in the Southern States. In 1888, of basic steel, Great Britain produced 408,594 tons. Of basic Bessemer pig-iron, Germany produced 1,253,308 metric tons. Deducting 15 per cent. for loss, this would leave 1,065,312 tons of steel. France is estimated to have produced 143,000 tons in 1887.

In 1889, in France, the aggregate annual capacity of basic converters was 500,000 tons.

Bessemer steel produced in the world.

Year.	Acid.	Basic.	Total.	Per cent. basic.
1881.	4,333,470	200,000	4,533,470	4.44
1888.	4,942,471	1,984,484	6,926,955	29.10

In the foregoing it is intended to give a general statement of this most important iron process, developed since 1878, without discussing the varieties of iron used or the steel produced.

SCHNEIDER ET CIE., CREUSOT, FRANCE.

This firm exhibited only basic slag and plants fertilized by use of it. They offer this material as a fertilizer, finely ground and sifted, at 30 francs per ton in bags, at their works; it contains from 12 to 18 per cent. of phosphoric acid. It has been shown that most of the acid is in combination with lime and as tetra-basic phosphate. The slag may be ground to the fineness of a 100-mesh sieve and applied without acid treatment. The phosphoric acid is regarded as half as valuable as a fertilizer as that contained in soluble phosphates. As the quantity of basic slag is nearly one-third as much in weight as the iron produced by the basic process, this material becomes a factor in the cost of the metal if a market can be made for it. In Germany 300,000 tons per annum are used, one-third of which comes from England and Austria.

CLAPP-GRIFFITH'S PROCESS.

This process employs a stationary converter, 1 to 3 tons capacity, with side blast and a slag spout at such a height that the slag runs out during the boil. There is a tap-hole through which the steel is removed at end of the blow. The bottoms are said to last much longer than those of the Bessemer converter, the linings about the same.

In the report of the American Iron and Steel Association for 1889, it is stated that the Clapp-Griffith's process does not grow in favor in America, no new plants having been erected in 1889, while the process was practically abandoned during the year at two works. Five Clapp-Griffith's plants with nine converters were employed in 1889 in the production of Bessemer steel out of six plants with eleven converters existing. Eighty-two thousand eight hundred and fifty net tons of steel were made here by this process in 1889. No noteworthy amount of Clapp-Griffiths steel was made in Great Britain in 1889. At several works the process has been discontinued. The product in 1888 was 20,000 tons; in 1887 25,000 tons. In France the process has been abandoned.

SOCIÉTÉ ANONYME DES HAUTS FOURNEAUX FONDERIE, FORGES ET LAMINOIRS DE STENAY (MEUSE), FRANCE.

Received a silver medal.

This exhibit consists of a great variety of weldable steel castings, produced by the Robert process, which employs a movable converter from 1 to 3 tons' capacity, a cross section of which has the shape of the letter D, and swings upon trunnions supported by suitable bearings. The tuyères are five or six in number, situated upon the straight side of the converter, in the same plane, horizontally, but at unequal angles with the straight side. The lining is either basic or acid, as may be desired. The acid lining may be made of highly siliceous bricks. The following composition gives good results:

	Per cent.
Silica.....	96.75
Alumina and oxide of iron.....	2.55
Lime.....	0.40
Various	0.30
	100.00

The mortar used must be very refractory.

If clay, sufficiently refractory, and capable of binding well when rammed, can be obtained, it is preferable to making the lining of composition. Its cost is less and construction is more rapid. The tuyères are either of burnt clay or made in the lining. The bottom lasts much longer than in Bessemer.

The basic lining consists of calcined dolomite, as free from silica as possible, powdered and mixed with 20 per cent. of coal tar, free from water. Bricks may be made of this mixture under heavy pressure, and joined by same mixture. The tuyères are situated near the melted surface of the iron bath, so that the blast does not penetrate through the whole bath, but only acts on the superficial layer, communicating a gyratory motion, bringing every part of the bath successively in contact with the blast.

The converter is also at certain stages tilted to aid the conversion. The metal is 10 to 15 centimetres in depth above the tuyères. The average pressure is 4 pounds. The blow lasts from 11½ to 14 minutes. At the end of the blow 1 per cent. of 70 per cent. ferromanganese is added.

At the Paris works the pig-iron used for acid steel contained:

	Per cent.
Carbon	3.50
Silicon	2.00
Manganese.....	1.00
Sulphur	0.05
Phosphorus.....	0.05

Average analyses of twenty-four samples acid steel at Stenay:

Carbon	per cent..	0.25
Silicon.....	do	0.144
Manganese	do	1.077
Tensile strength per square inch	tons...	31.3
Elongation	per cent..	16.3

Pig-iron, which gave best results with basic process, contained:

	Per cent.
Sulphur	.04
Manganese.....	1.80
Phosphorus.....	2.0 to 2.5
Silicon	0.50

The slag contains from 15 to 25 per cent. of phosphoric acid.

Basic steel made at Blaenavon Works.

	1.	2.	3.	4.
Carbon	.112	.122	.102	.084
Silicon.....	.027	.022	.035	.100
Sulphur.....	.136	.048	.032	Trace.
Phosphorus.....	.080	.052	.049	.076
Manganese	.258	.411	.307	Trace.

It is claimed that with a much smaller or much cheaper plant than the Bessemer plant the composition of the resulting steel can be regulated, and that by the acid process steel of any desired quality

can be produced, especially for castings of high quality of soundness and finish; that by the basic process a peculiarly soft ductile metal is produced.

The process is in use at Stenay, and in Paris, and at the Blaenavon Works in England. The foregoing statements are mainly from a paper read before the Iron and Steel Institute of Great Britain by F. L. Garrison.

In the report of the American Iron and Steel Association for 1889 it is stated that this process was introduced in the United States in 1888 at Springfield, Ohio.

During 1889 six other plants were completed and one commenced. Six of these plants with ten converters made steel, mainly for experimental purposes, and the quantity produced was very small. The plants are all small and most of them are designed for making castings.

MANUFACTURE OF BASIC OPEN-HEARTH STEEL AT THE BRYMBO STEEL WORKS, BRYMBO, WALES.

The following extracts from a paper by J. H. Darby, of Brymbo, read before the Iron and Steel Institute of Great Britain, best describes this process:

The next work was that of designing and building four 12-ton and afterward two 20-ton furnaces. They were arranged in a line, the charging platform on one side being a sufficient distance above the floor of the works to admit the casting ladle and carriage, which runs on rails over a pit parallel to the furnaces.

Each furnace is provided with a separate chimney, ordinary butterfly reversing valves of ample size, and regenerator chambers of large capacity, but similar in shape and construction to most modern open-hearth furnaces.

The furnace proper is composed of two wrought iron sides supported by H-iron buck-staves, well braced together at the top and bottom. The ends are left open, holes are cut in the plates for the three doors on the front side of the furnace and another hole is made at the back for tap-hole plates. The plates are also cut away to allow air to circulate for cooling purposes under the furnace bottom and bridge plates. The bottom of the furnace is built up of cast-iron plates, supported on H-iron girders, so as to form a rough outline of the furnace bottom when lined and ready for work. The girders rest on angle iron attached to the side plates. Any movement or subsidence in the chambers must therefore affect the hearth as a whole. This prevents cracking of the material of which the hearth is composed. The silica blocks at each end of the furnace are built in the usual manner, but the roof and side walls are built after the hearth has been rammed in. The former is placed some way above the metal, so as to avoid splashing of the basic slag. The

roof is level from block to block; the ends, however, are well inclined to bring the flame down on the metal.

On the iron plates for holding the dolomite hearth fire bricks are placed so that no part of the basic hearth when finished is more than 15 inches thick. As soon as all the brickwork is dry, hard burnt dolomite, well ground and mixed with as little anhydrous tar as will make it stick together when compressed, is rammed with hot irons until the desired shape of the hearth is built up. The tap-hole is made by a round piece of wood, which is left in and burnt out as the furnace heats up.

The shrunk dolomite or basic material is brought up to the bottom of the doors, and to an equal height all round. On it a layer of about 2 inches of chrome ore, also ground fine and mixed with tar, is rammed to act as a neutral separator between the acid and the basic portions. Chrome ore is also rammed in between the silica blocks and the basic hearth. The side walls and jambs are built in the chrome ore. The roof is then put on and the furnace heated up at first with a coal fire. There should be no stoppage in putting in a hearth and finishing the roof. A 20-ton furnace should thus be completed in 36 to 40 hours. When the furnace is properly dried and heated the hearth will become very hard. The tap-hole should be cleaned out, and then filled with dry ground basic material for several inches. This should be well pushed up against a scraper held from the middle door. Anthracite coal is then rammed in and the outside of the tap-hole is covered with damp sand.

The charge may now be introduced.

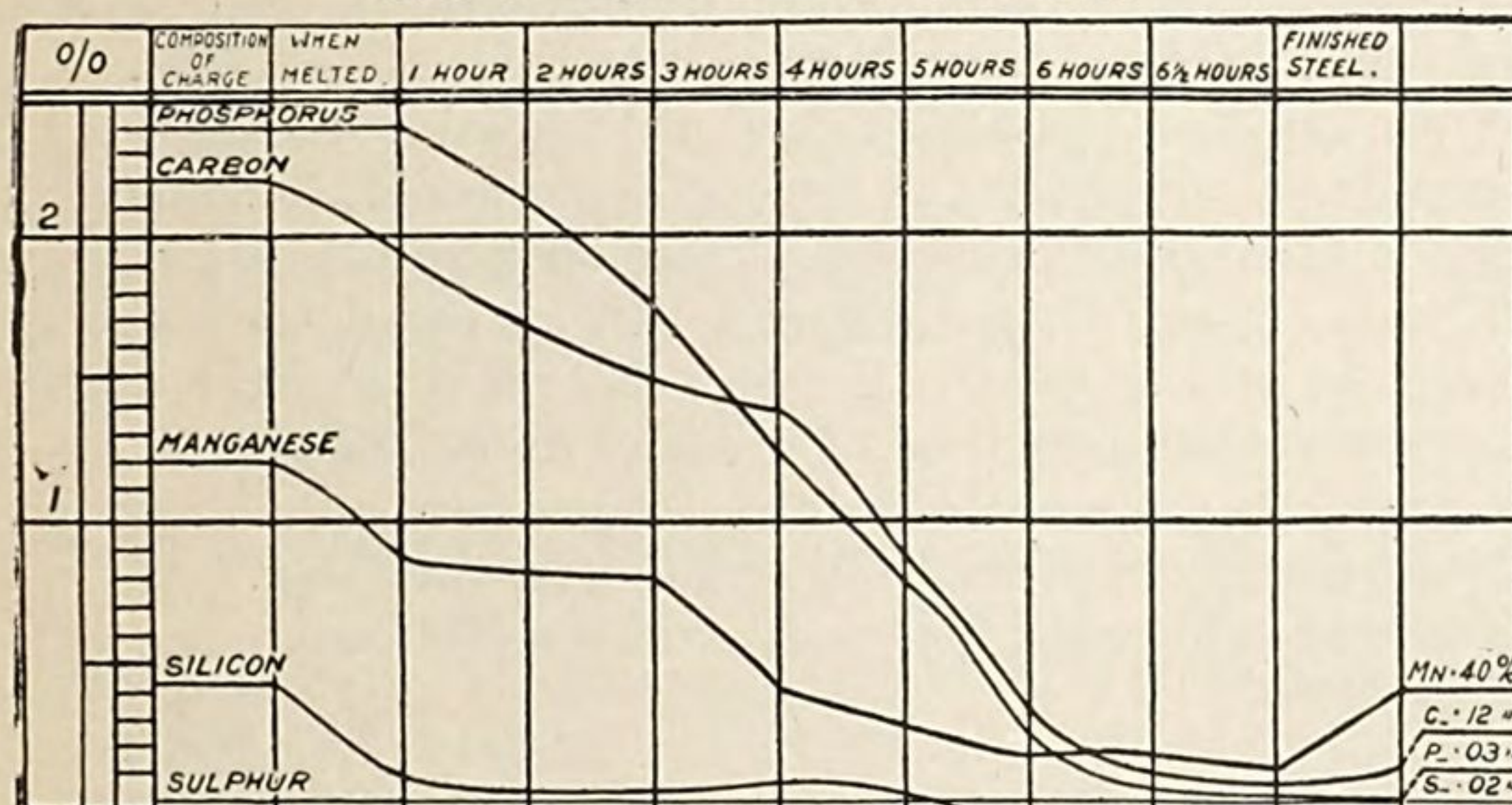
The pig-iron contains carbon (combined) 3.20, phosphorus 3.00, sulphur 0.04, silicon 0.40, manganese 1.75. I use 80 per cent. pig and 20 per cent. scrap. The pig I have described. The scrap is composed of either steel or wrought iron. The percentage of phosphorus in wrought iron is not injurious. Limestone is usually charged in sufficient quantity to make a basic slag from the first. Scrap and pig follow. When melted and sufficiently hot, additions of iron ore and limestone are made at intervals during about five hours. The first sample is taken, and from its appearance and fracture it is judged if sufficient ore has been added. If so, as much as possible of the unspent oxide is reduced in the slag by reacting on the remaining impurities, lime additions being made from time to time. The hammered sample rapidly improves. The edges, which were rough at first, become smooth and free from cracks, the surface of the sample is clean, and when the charge is ready it will bend over into four thicknesses without any indication of cracking. Ferromanganese is then added, part in the furnace and part in the ladle, and the charge is trammed. It runs quietly and solidly, as shown by the fact that the total loss in the mill, including furnacing,

crops, and cobbles, is only 8 per cent. in the weight of the ingots produced—that is, in rolling billets, bars, and slabs.

Any kind of iron ore may be used in the steel furnaces, providing it contains a low percentage of silica. Phosphoric acid in the ore does not matter; the phosphorus is already oxidized and is taken up by the lime. Phosphorus can be as easily eliminated from pig-iron with pottery-mine as with hematite ore.

The diagram which I have had prepared was worked with 3.1 cwts. of pottery-mine, and that was equal to 4.2 cwts. of good rough carboniferous limestone per ton of ingots.

BASIC OPEN-HEARTH CHARGE.



The 20-ton furnaces make from 180 to 200 tons of ingots per week, or 25 cwts. per hour, exclusive of Sundays.

The yield of ingots from the weight of pig, scrap iron, and ferromanganese used, inclusive of iron reduced from the ore, is 93.5 per cent. The consumption of fuel, inclusive of Sundays and heating up furnaces that have been off, is 11.07 cwts. per ton of ingots.

Repairs to the hearth are made with ground dry basic material alone after each charge, if the furnace requires it, as is generally the case to some extent round the slag line. The repairs are quickly effected, and the furnace is at once ready to charge.

In the basic Bessemer process I understand that as much as 30 pounds of 80 per cent. ferromanganese is used per ton of steel. In the basic open hearth 10 to 12 pounds per ton is all that is required to give an equal percentage of manganese in the final steel. This seems to me to indicate a striking difference in the composition of the purified material from the two processes. After experience in the manufacture of over 60,000 tons of basic open-hearth steel, I can say I have never seen "red short" material in our usual soft quality, although I have kept a strict lookout for it. If care is taken to keep the sulphur low, say to 0.02 per cent., which is about our average, and if at the same time the excess of oxide is well worked out of the steel

prior to tapping, the metal will work and weld freely with a very small addition of manganese.

I have obtained 3,660 tons of dead soft steel from one furnace without relining, and it is still at work. The hearth has never been out of order since the furnace was started last December.

Molten pig-iron direct from the blast furnace was at one time poured onto the heated scrap in the open-hearth furnace; but although the hearth was well protected with limestone spread over the bottom, it was most rapidly destroyed, notwithstanding it had been in good condition previously. This method of charging was therefore abandoned. I may, however, say that the duration of the charge was shortened, and if the bottoms could be made to stand, it would be a considerable advantage.

I retain all the slag until the end of the charge, and as this is 25 to 30 per cent. of the weight of the metal produced, it will be readily understood that a furnace for the basic open-hearth process must be considerably larger than a furnace with an equal tonnage capacity working the acid process. Running slag off during the working of a charge means the wasting of oxide of iron. Slag from the basic open hearth usually contains 13 to 14 per cent. of phosphoric acid and has fewer shots of steel than basic Bessemer slag.

An average analysis of our soft steel is as follows:

	Per cent.
Carbon	0.12
Phosphorus.....	0.03
Sulphur	0.018
Silicon.....	Nil.
Manganese.....	0.40

This steel gives about 24.5 tons tensile strain per square inch and 15 tons elastic limit, with an elongation of 31 to 33 per cent. in 8 inches.

I would say in conclusion that I attach great importance, if uniform results are required, to the composition of the pig-iron. A suitable pig is as necessary in the basic as in the acid process of steel making, but it offers no more difficulty in manufacture.

FOULD-DUPONT, AT POMPEY (MEURTHE-ET-MOSEL), FRANCE.

The house originated in 1836; present works commenced in 1872; number of workmen 1,400 to 1,500.

The works include two blast furnaces, producing each 110 to 115 tons per day; twenty-five puddling furnaces, producing 150 tons per day; one Seimens-Martin furnace, magnesia brick lining, 36 to 42 tons per day, three heats; rolling mills producing 130 tons per day; six hammers, 1 to 3.5 tons, producing 150 to 200 tons of forgings per month; foundry producing 120 to 150 tons of castings per month. The shops turn out 100 to 200 tons finished work per month.

The works produce merchant iron and steel, plates, castings, and architectural work.

Exhibits.—Port d'Entrée of Class 41, in the Grand Gallery of 30 metres. This is composed of bars and plates of iron and steel, as types of rolling, ornamented by forgings, as types of finished pieces; volutes, and festoons of steel plates curved cold, as types of the quality of metal; and bucklers and casques examples of hammering and polishing. The pillars are composed of iron beams and shapes and large steel plates, and the columns of small profiles assembled in a circle. The arches carry guard-plates of the state railroads; the cornices, the couplers of the Southern Railroad, alternating with buffers of the Northern Railroad; the pillars, a variety of axles and buffers. The whole construction weighs 73 tons. It is a most ingenious as well as a beautiful exhibit, and extremely effective.

There are also large plates of steel, samples of ores, ingots, etc. All the iron for the Eiffel tower, amounting to 7,000 tons, was furnished by these works. They received a grand prize.

JACOB HOLTZER & CO., UNIEUX (LOIRE), FRANCE.

Founded in 1829; employs 800 to 1,000 men; consumes 30,000 tons of fuel.

Annual production.—4,000 tons crucible steel, of various qualities; 600 tons rolled steel; 3,000 tons puddled steel; 1,000 tons puddled iron; 2,500 tons cement, steel, and iron; 500 tons, parts of machines, etc.; 300 tons, bodies, tubes, and hoops of cannon, which do not require ingots of more than 3 tons; projectiles of forged and cast steel, up to 1 ton each; 200 tons sheets and plates of chrome steel, for protection.

The works include seven crucible furnaces, heated by gas, each holding thirty crucibles; each crucible holds 25 to 30 kilogrammes; metal and ingots as large as 3 tons are cast. The full daily product is 35 tons; twelve cementation furnaces, six of 30 tons' and six of 15 tons' capacity; eight to nine operations a year are made with each furnace; twenty-four hammers, 2 to 15 tons, rolling mills, machine shops, etc.

EXHIBITS.—*Ferro-chrome manganese.*—Chromium, 7; carbon, 4.35; manganese, 0.30.

Tungsten steel.—Up to 10 per cent tungsten, so-called mushet steel, for tools, without tempering; difficult to forge. Also a variety of steels, including carbon steel, chrome steel, chrome tungsten steel, manganese steel, silico-manganese steel, and copper steel; the latter up to 4 per cent. copper, but merely a study.

All these alloys are made in crucibles, the masses being 7 inches diameter 10 inches high.

The exhibit includes steel castings, steel bars of various kinds,

tools, parts of cannon, chrome steel projectiles first made by them in 1882, chrome steel plates up to 2 inches thick, for protection from shot.

This firm was out of competition, one of its members being on the jury.

For superior quality of tool steel Swedish iron is used, about 600 tons per year being consumed. Tungsten steel for tools is also made. This firm exhibited a large number of alloys.

Chromium carburets.

Chromium....	80	71.5	60 per cent.
Carbon.....	11	3.46	8.6 per cent.

Type of ordinary manufacture:

Chromium....	48 to 53 per cent.
Carbon.....	8 per cent.

Silico chrome

Chromium...	82	30	30	42
Carbon.....	7.5	5	5	7.3
Silicon.....	8.2	8	8	2.1

Ferro chrome.

Chromium....	30	30	25	16	15	16	12.5	12	7	7
Carbon.....	sat.	4.7	3.8	9	2.25	2.7	sat.	2	sat.	1.2

Chromium 12, carbon 2, is not commercial, limit for cast iron and steel.

Limit for projectiles or tool steel is, chromium 1 to 3 per cent., carbon 1.5 per cent.

COMPAGNIE DES FONDERIES, FORGES ET ACIERIES DE ST. ETIENNE
(LOIRE), FRANCE.

Founded 1865. Capital, 4,000,000 francs.

This company produces in acid and basic Siemens-Martin furnaces steel of various grades, with silicon, carbon, and chromium. They have no crucible plant and, with one exception, are the only manufacturers of projectiles of chrome steel in basic open-hearth furnaces. They endeavor to replace crucible steel in many of its applications, tools, cutting instruments, etc.

Composition of steel, parts in 10,000.

Quality.	Carbon.	Manganese.	Silicon.	Sulphur.	Phosphorus.	Chromium.
Z t	100	20	30	1	1	150
X 1	95	30	40	1	1	0
X 2	85	30	40	1	1	0
X 3	75	50	40	1	1	0
X 4	68	55	40	1	1	0
X 5	60	55	30	1	1	0

In regard to projectiles, they exhibited one of chrome steel 34 centimetres in diameter, which, having penetrated an iron plate of 40 centimetres, exhibits no appreciable deformation. It has been claimed that only projectiles of small caliber could be successfully made from open-hearth chrome steel.

The forging plant includes thirteen hammers, from 2 to 50 tons. Forging over a mandrel is practiced with hollow pieces. The rolling mills produce 10,000 tons of steel and 16,000 tons of iron and steel plates per annum.

The tempering is done by oil or water. The hoops for cannon are tempered in a special bath of a current of cold water. The company have taken the initiative in a process called central tempering with water, which seems superior to the total immersion in oil or water, for cannon tubes, or sleeves of great length. A current of cold water ascends within the piece, which has been properly heated, until cooling is complete. The cooling takes place first with the interior molecules, gradually proceeding outward, and it is claimed a greater uniformity is obtained.

The method of procedure for making chrome steel in basic open-hearth furnaces, as practiced by another maker, is given by Henry M. Howe. The carbon being brought to the desired point, ferro-chrome is added, allowing 20 per cent. loss of chrome. The chromium prevents blow-holes and gives forgeableness. When melted, the charge is tapped.

The exhibit consisted of tires, a crank shaft, trunnion hoops for a cannon of 42 centimetres caliber, plates of iron, steel, and chrome steel, a special steel to replace chrome steel plates of protection, axles, tube forged hollow over a mandrel, steel plate 20 centimetres thick, rudder of cast steel for cruiser *Alger*, and other steel castings, cannon, and projectiles, and a wheel entirely of forged steel. This company received a grand prize.

**SOCIÉTÉ ANONYME DES ACIERIES ET FORGES DE FIRMINY (LOIRE),
FRANCE.**

Founded in 1854; made a stock company in 1867; area of property, 76 acres; capital, 3,000,000 francs. Sum total of business in 1888, 6,331,800 francs; in 1883, 12,245,425 francs. Employ 2,000 workmen, 58 steam engines, of total 3,000 horse-power.

This establishment includes one blast furnace, daily product, 100 tons; eight Siemens-Martin furnaces (here this process was first used commercially); twenty puddling furnaces; two cementation furnaces; three Siemens' gas furnaces, for crucible steel, forty crucibles each, with the necessary forging and rolling machinery; machine shops, etc.; twelve hammers, 1 to 30 tons.

The ore is obtained from mines of Mokta-el-Hadid (Algeria) and La Fragua (Spain), which latter is the property of the company. The

metal contains not more than 0.004 per cent. of phosphorus and trace of sulphur.

For producing high grade iron from ordinary pig, the Rollet refining process is used. The pig is melted in a basic-lined or water-jacketed hot-blast cupola furnace with fluor-spar and lime, by which most of the sulphur and some of the phosphorus is eliminated.

A great variety of steel is produced at these works, from ordinary to fine quality, cement steel, chrome steel, spiegel and silico-spiegel. The latter contains not higher than 20 per cent. silicon. The exhibit consisted of various samples of these products, with analyses and tests, with steel castings and forgings, and rollings for various purposes. Shafting, axles, springs, tires, wheels, cannon, anvils, industrial tools, agricultural tools, projectiles of cast and forged steel and of chrome steel, wire, galvanized and copper coated, and for pianos of cast steel. Their piano wire showed the highest tensile strength. This company received a grand prize.

MARREL FRÈRES, FORGES DE LA LOIRE ET DU MIDI RIVE-DE-GIER
(LOIRE), FRANCE.

The members of this firm inherited their metallurgical tendency from their grandfather, François Marrel, who had a small factory at St. Martin-la-Plaine (Loire). On his death in 1823 the son Charles closed the factory and sought employment with another manufacturer. In 1845, with four of his sons, he reopened the factory. In 1853 the six sons formed the present firm and founded the present works. From that date to the present time the progress has been continuous. The firm has three establishments. That at Rive-de-Gier occupies 5 acres, and here is produced pieces of large dimensions for the national and merchant marine up to 35 tons; cannons of medium caliber up to 8 metres in length; projectiles of all kinds to 32 centimetres caliber. The works at Etaing were founded in 1867 and are the most important. They occupy 30 acres. Here are four Siemens-Martin furnaces of 35 tons each, twelve puddling-furnaces, two batteries of forty crucibles each, a 50-ton hammer, one hydraulic press of 4,500 tons and one of 2,000 tons, a rolling train for armor-plates with rolls $3\frac{1}{2}$ feet diameter, 11 feet length, and $3\frac{3}{4}$ feet opening, and the necessary machine-shops, etc. A hammer of 100 tons, 6 metres maximum fall, under construction. Here are made armor-plate, cannon and projectiles of large caliber, and other large forgings. The works at La Capeletto were founded in 1855 and occupy 6 acres. Here are made forgings up to 10 tons; ships' anchors and chains, by a patented process, of all sizes; also, the assembling, by welding of elements, of large pieces. From 1860 to May, 1889, this firm has furnished to France and other Governments 43,520 tons of plates, simple and compound. From 1870 to May,

1889, they have produced 3,525 pieces of ordnance, from mountain howitzers of 3 inches to cannon of 13½ inches caliber.

The exhibits consist of iron crank-shaft for steamship, 19.8 tons; iron intermediate shaft for steamship, 13.2 tons; iron crank-shaft for steamship, 9.8 tons, finished; iron crank-shaft for steamship, 17.65 tons; anchor, 3.5 tons; anchor, articulated, 3.5 tons; chains, 56 to 70 millimetres; beams and angle of steel; plate for deck of ship, 17.200 by 2.920 by 0.060 metres thick, weight 26.3 tons; armor-plate, compound, 3.670 by 1.880 by 0.350 metres thick, weight 18.65 tons, one-third steel; series of tubes and bodies of cannon and mortars for land artillery, 80 to 240 millimetres diameter; series of tubes and bodies of cannon for marine artillery, 14 to 32 centimetres; hoops and trunnion-hoops of various dimensions, projectiles of chrome steel of various calibers, also model (one-tenth) of the 100-ton hammer.

This firm was awarded a grand prize.

COMPAGNIE DES HAUTS-FOURNEAUX, FORGES, ET ACIERIES DE LA
MARINE ET DES CHEMINS DE FER, SAINT-CHAMOND (LOIRE), FRANCE.

Had its origin in 1842. Capital 20,000,000 francs; 6,000 workmen.

The company owns five works in France: St. Chamond, Assailly, Rive-de-Gier, Givors, and Adour; in Corsica, a blast furnace at Toga; also coal mines in the basin of the Loire, iron mines of St. Leon, Sardinia, and forests in Laidinia, for the supply of fuel to the furnace at Toga.

At St. Chamond there are open hearths of daily output of 60 tons, puddling furnaces of daily output of 8½ tons, hammers 5 to 15 tons, trains for rolling tires, rails, and shapes, plate mills for plates up to 2.20 metres wide; installation necessary for producing compound armor plates; a press of 4,000 tons, tools for finishing 4,000 tons of plates per year; hammers of 100, 35, 10, and 2 tons' weight, machine shops, and tempering plant.

At Assailly are five cementation furnaces, of 20 to 24 tons, four crucible furnaces, heated by gas, of 24 crucibles each, of daily capacity of 12 tons of ingots, and six puddling furnaces. Here is produced steel for tools and cutlery; here was established, in 1860, the manufacture of guns from cast steel, the monthly production reaching since that time 40,000 stands of arms.

At Rive-de-Gier, two shops, one for manufacture of pieces for naval construction, shafts, sternposts, etc., and axles of iron and steel for railroads. Annual production, 7,000 tons; eighteen hammers, 3 to 30 tons.

The other shop is for fabrication of wheels for locomotives and wagons; also for forging of wheels and projectiles. Six hammers, 2 to 40 tons. Annual product, 25,000 wheels, 5,000 to 7,000 tons.

At Givors are three blast furnaces, 50 to 60 tons' daily product, two

Bessemer converters, and two batteries of coke ovens. Annual product, 40,000 tons pig-iron, 20,000 tons steel.

At Boucan are the forges of Adour, built in 1882 to 1884. There are here three blast furnaces of 60 tons' daily output, with coke ovens; two Bessemer converters; two open-hearth furnaces of 10 tons, rolling mills for rails, shapes, etc., capacity 70,000 tons of rails per annum; rolls for merchant iron and a shop for producing tires, with hammers 6 to 12 tons. The total product has reached for a month 8,000 tons of pig-iron and 6,000 tons of rails or other products.

The exhibits include model of ingots of 100 tons, such as are now being forged for tube for cannon, 34 centimetres caliber and 42 calibers long; plate for cupola of a turret, 27 tons weight; plates of various dimensions, steamship shaft 14.5 tons; cannon tubes up to 34 centimetres, 14 tons; axles for artillery, hoops for cannon; railroad axles and tires; projectiles up to 42 centimetres and shells; turrets for land defense; repeating rifle; rapid firing cannon and various kinds of cannon; steel and iron rails and shapes, wheels, axles, tires, and steel railroad ties, system David; also large collection of samples and fractures of steel and iron with analyses. The ferrochrome contains 38 to 45 per cent. chromium.

Ferrotitanium, up to 22 per cent. titanium. Titanium steel contains 0.45 per cent. titanium.

This company was out of competition.

COMPAGNIE ANONYME DES FORGES DE CHATTILLON ET COMMENTRY.

Capital 12,500,000 francs. Founded 1845. Stock company 1862.

This company has the following works: At Montlucon St. Jacques (Allier), blast furnaces, forges, steel plant and shops of construction; at Commentry (Allier), blast furnaces and forges; at Beaucaire (Gard), blast furnaces; at Villerupt (Menthe-et-Moselle), blast furnaces; at Sainte Colombe, Ampilly, Mussy, and Chameçon (Cote-d'Or), and at Plaines (Aube), forges and wire mills; at Tronçais (Allier), wire and cable mills; at Morat (Allier), special wire mills; at Vierzen (Cher), wire mills; at Cher, Indre, Villerupt (Menthe-et-Moselle), Butte (Alsace-Lorraine), ore mines; at Bezenet, Doyet, Les Ferrières (Allier), St. Eloi (Pay-de-Dôme), coal mines.

The annual product of the coal mines is 400,000 tons.

[PRODUCTS.]

Material of war for land and sea.—From 1867 to 1888 this company has furnished to the French Government 14,000 tons of iron plates and 7,000 tons of compound plates for ships; of twenty-five turrets this company has supplied twenty-one; in 1887 they constructed two land turrets for experiments at the camp of Chalons, one of one cannon, the other of two cannons, with eclipse, in con-

nection with the Compagnie de Fives, Lille, also a casemate of Hotchkiss type. They have also constructed for Belgium thirty-two of the sixty-three large cupolas of one and two cannons. Since 1875 they have furnished 70,000 projectiles of all sorts, besides 200,000 Hotchkiss projectiles from 1880 to 1885. Tubes and hoops for cannon of puddled or cast steel are made at Montlucon, St. Jacques. From 1887 to 1889 they have made twenty-one wire torpedo guards for the government at Tronçais. Plates for marine construction and boilers are made at Commentry.

Manganese steel.—This company has made experiments with this metal, under the patents of R. A. Hadfield. (Journal of the Iron and Steel Institute, 1888, II.) With a composition of manganese 13.75, carbon 0.85, silicon 0.23, this metal has a tensile strength of 145,600 pounds per square inch and an elongation of 51 per cent. in 8 inches. It is very hard and practically non-magnetic. It is made by adding ferromanganese in a melted state to decarbonized iron.

Products of high grade for commerce.—Crucible steel for tools; steel castings; products for railroads, wheels, and tires; cables of any resistance and composition; wire of iron or steel of resistance from 60 to 220 kilogrammes per millimetre; piano wires.

Ordinary products for commerce.—Iron and steel in all forms, rolled, forged and cast; pig-iron, spiegel, and ferrochrome; charcoal and coke.

The exhibit included a large number of steel castings for ships, wheels, axles, tires for railroads, plates for protection, tubes for cannon, projectiles, armor-plate, iron and compound, wire of all kinds and cables, torpedo guard-nets, fracture samples of various steels and irons; carbon, tungsten, and chrome steels. Machine for measuring the dilatation of metals at elevated temperatures, designed by A. Evrard. Lunette pyrometrique of Messrs. Mesure and Nouel, for determining the temperature of incandescent bodies. This instrument was made by E. Ducretet, 75 rue Claude Bernard, Paris.

Lead tempering.—This company employ the method devised by its former director-general, Alfred Evrard, whom we quote:

The process of immersion which we have adopted consists in maintaining the pieces of cast or forged steel at a continually uniform temperature in their entirety when they are once heated to the point where the transformation of the metal occurs and when flaws are liable to result.

To realize this principle we submerge in a metallic bath composed of molten lead the pieces which have been heated, and we leave them to cool at will in this bath. Metallic baths, as is well known, possess a special conductivity, which is eminently superior to that of liquids—such as oil or water—and avoid also the production of vapor, which, in ordinary systems of tempering, spreads itself around the submerged piece and prevents the free transmission of heat.

With our process the whole mass of the submerged piece is kept in a continual evenness of temperature with the bath itself, and the change in position of the molecules can go on freely in the interior of the piece, whether this change is the transformation of the grain of the metal or its contraction while cooling, and this

whole change is effected without interior tension. We obtain by this means absolutely perfect pieces, very regular in make, and which have given results in our different trials of them which are notably better than those obtained with pieces treated by the ordinary methods.

It must be remembered that this process, compared with the usual methods of forging, tempering, and reheating, requires, on account of its delicacy of treatment, a thorough knowledge of steel working and the condition of the steel to which it is applied. The temperature, of course, must be varied considerably, according to the kind of steel operated upon, as we have observed in our experimental researches that the composition of different steels and the accessory circumstances exert, on their side, a decided influence, which must not be neglected and which can not be appreciated without sufficient experience.

Guiding ourselves by the theoretical and experimental results thus obtained, we have been able to determine, for each nature of steel, the most appropriate application of our process and have obtained thereby the most satisfactory results.

Circumstances may be such as to make it expedient not to surpass the temperature of the fusion of lead.

In order to obtain the best results we found that a voluminous bath capable of submerging the largest pieces was necessary. It was then possible to vary the depth and space of the bath by the introduction of quantities of molten metal, which act at the same time as refrigerants. It will be understood that if parts only of the bath were to be allowed to cool and were then remelted for an ensuing operation, the continuity of the process would be destroyed and the process itself rendered impracticable.

The furnaces, which we use for melting the lead which serves for the immersion of the pieces, can be directly heated so as to permit the passing of the point of fusion, if necessary, and thus keep the bath at the desired temperature for the tempering process.

We have constructed a considerable outfit in order to insure facility, rapidity, and precision in handling large pieces. We have arranged machinery for the dipping of the pieces, filling in blocks, etc., allowing us to vary the form and level of the same. Finally, we have completed our plant by the adoption of optical instruments, allowing of an exact and rapid notation of temperature. It has been proved by our experimentation that the hardest of steels and metals of every composition treated according to our process are not subject to flaws in tempering. At the same time the grains of these steels were notably modified, and when the temperature of heating was correct the grains came out very fine and regular.

The tempering of a cannon gave us analogous results to that which is obtained by tempering with oil, followed by reheating. The tensile strength, and especially the resistance to shock of hard steel, was notably increased. This same result was also obtained with cast pieces.

This company received a gold medal.

Ice tempering.—At the works at Creusot ice tempering has been used to some extent with plates up to 2 inches thick, we understand.

SOCIÉTÉ ANONYME D'ÉCLAIRAGE AU GAZ ET DES HAUTS-FOURNEAUX ET FONDERIES DE MARSEILLE ET DES MINES DE PORTES ET SENECHAS, ST. LOUIS, MARSEILLE (BOUCHES-DU-RHÔNE), FRANCE.

This company exhibited pig-iron of various qualities, spiegeleisen, ferromanganese to 87 per cent. manganese, ferrosilicon to 14 per cent. silicon, silico spiegel to 14 per cent. silicon, and ferrochrome to 65 per cent. chromium, a long series of each variety.

This company was out of competition.

SOCIÉTÉ DES ACIÉRIES DE LONGWY, MORET-ST.-MARTIN (MEURTHE-ET-MOSELLE), FRANCE.

Origin, 1863; stock company, 1880; capital, 20,000,000 francs; one thousand five hundred and ninety-two employés and workman; six iron mines: seven blast furnaces; three basic converters, 15 tons each; rolling mills, shops, foundries, etc.

Product: Thomas pig-iron, 86,520 tons; other pig-iron, 22,722 tons; steel, all kinds, 70,653 tons; basic steel, 250 to 300 tons per day.

The iron ores range from 26 to 42 per cent. iron, the former calcareous, with 0.50 to 0.70 per cent. phosphorus and 0.10 to 0.30 sulphur.

The Thomas pig contains—

	White.	Mottled.
Manganese.	1.50	2.00
Carbon.....	3.00	3.20
Silica	0.20	0.35
Sulphur.....	0.04	0.02
Phosphorus.....	2.00	2.20

The phosphorus in the steel ranged from 0.05 to 0.10 per cent., with traces of sulphur. The basic slag contains 15 to 16.5 per cent. phosphoric acid, and 60 to 70 tons per day is produced.

The exhibits consisted of samples of raw material and products, ingots, blooms, billets, plates, rails, bars, forgings, etc.

This company received a grand prize.

COMPAGNIE DES MINES, FONDERIES ET FORGES D'ALAIS (GARD), FRANCE.

Capital, 9,000,000 francs; founded, 1830; iron and coal mines; six blast furnaces; Siemens-Martin furnace, puddling furnaces, rolling mills, hammers, and chain works.

The exhibit consisted of foundry pig, six classes; forge pig, four classes; spiegel 10 to 20 per cent. manganese; ferromanganese up to 80 per cent. manganese; ferrochrome 48 per cent. chromium; ferro-silicon 14 per cent. silicon; also iron and steel, rolled and cast in various forms; samples of ammonia and tar from coke ovens; system, Carves. The tar is rich in anthracene.

FORGES D'HENNEBOUT, HENNEBOUT (MORBIHAN), FRANCE.

The exhibit consisted of cast steel and iron, sheet iron and tin plates, stamped and decorated ware; very soft steel obtained in basic hearth furnaces, with magnesia brick linings; patent of Emile Muller, 1869.

VALTON-REMAURY, PARIS.

He exhibited neutral refractory materials, products resulting from their employment, and drawings of apparatus in which they were used. This is a process for the manufacture of steel and iron. As described by V. Deshays in *Le Genie Civil*, it consists in the use of chrome iron ore for beds and walls of open-hearth furnaces. It should contain 40 to 45 per cent. of chromium oxide. That from Greece, Asia Minor, and Sweden is best. The lumps are built in, using a mixture of limestone, as free from silica as possible, and the powdered ore as mortar, two of ore to one of limestone. Tar is used as a binding material for sides of charging doors and closing the tap-hole. On burning, the ore combines with the lime, forming a hard coherent mass, which does not fall to powder. None of the chromium passes into the bath of molten metal.

On starting, 6 to 10 cwt. of limestone are charged in when the furnace has reached the proper temperature, to protect the bed and provide lime for dephosphorization. An excess of limestone must always be employed. If there is sulphur in the pig, manganese ore must be added to the charge, giving six to seven times as much metallic manganese as sulphur. After the limestone has disintegrated, it is spread over the hearth, the pig and scrap being charged in. For a charge of 6.5 tons, 1.7 tons of pig and 0.6 tons of cast-iron scrap are charged in. When this is melted the preheated iron scrap is charged in 6 to 10 cwt. at a time. The slag is tapped as soon as possible and more scrap is added until the bath is quiet. To eliminate the last traces of phosphorus, balls of lime and hammerscale are added to the bath. The metal produced is very soft. (Valton-Remaury also recommend the use of this ore for basic converters and cupolas.)

This lining was first used by Compagnie des Mines, Fonderies et Forges d'Alais, in 1885.

SOCIÉTÉ ANONYME MITIS BELGE, HUY, BELGIUM.

The exhibit consisted of a great variety of castings of Mitis iron, Nordenfelt's patent.

The Mitis process is dependent upon the discovery by Wittenstroem, of Stockholm, and Nobel, of St. Petersburg, that the addition of a small quantity of aluminium to wrought iron, heated until pasty, causes the iron to liquefy at once, so that it can be poured into castings having all the properties of wrought iron except fiber, and as sound as cast-iron. The experiments were made in 1883 and 1884, and the manufacture of Mitis castings was commenced in 1885, in Nordenfelt's foundry, in Carsvick, Sweden, and Nobel's foundry, St. Petersburg.

The charge consists of wrought-iron scrap, if softest product is

desired, mixed with more or less steel scrap or cast-iron for harder products. The presence of phosphorus much above 0.1 per cent. is found to be injurious, and with scrap steel manganese interferes with the production of good castings. The furnace used is Nobel's petroleum furnace. The charge is placed in covered crucibles and heated to $2,200^{\circ}$ C., the point of becoming pasty. Several hundred degrees increase of temperature would be required to melt the iron so as to be able to cast it without the addition of aluminium, during which time absorption of gases would take place and the consequent deterioration of the metal.

On adding to the charge, in the pasty condition, ferro-aluminium containing 8 per cent. aluminium, equivalent to 0.05 to 0.10 per cent. aluminium, the charge immediately liquefies and may be cast in molds of sand or iron. When the furnace is fully heated, the melting takes place in three-fourths of an hour.

The castings are smooth, ductile, may be forged and welded, have all the properties of wrought iron, and an increase in tensile strength. They may replace malleable iron castings.

Numerous analyses have failed to find any aluminium in the castings, and at most 0.02 per cent. have been detected. The explanations offered by various authorities of the action of aluminium are that the aluminium reduces the dissolved oxide of iron, which makes the charge pasty; that the evolution of gas ceases because the aluminium combines with all the oxygen present; and the greater fluidity of the metal allows the gases, entangled during the castings, to escape and thus lessens the blow-holes.

It is said that the process is in use in five American establishments, and abroad in Austria, Belgium, England, France, Germany, Russia, and Sweden.

GJERS, MILLS & CO., AYRESOME IRON WORKS, MIDDLESBROUGH, ENGLAND.

This company exhibited samples of foundry and hematite pig-iron, ferrosilicon and silicospiegel. Also models of blast furnace plant and Bessemer steel works with Gjers soaking pit and enlarged section of pit.

SILICOSPIEGEL—FERROSILICON.

Silicospiegel is used by steel founders for mixing with molten steel in the manufacture of solid steel castings, free from blow-holes; it is also used in place of ferromanganese, and has the effect of making the molten steel more fluid, and thus produces a cleaner casting. If an extra soft steel is required for special steel plates, silicospiegel is

used in place of ferromanganese, and the quantity to be used varies from $1\frac{1}{2}$ to three-fourths per cent.; the extra quantity can only be arrived at by experience, and varies according to the quality of the steel used. The above remarks apply to silicospiegel, but, where ferrosilicon is used, ferromanganese must also have been previously used in the manufacture of the steel, and the quantity of ferrosilicon required is from 1 to three-fourths per cent. The best steel founders in this country prefer to use silicospiegel rather than ferrosilicon.

In steel casting the silicospiegel or ferrosilicon may either be put into the molten steel in a Siemens-Martin furnace, or it may be put into the ladle in which the steel is run from the furnace; and in the case of Bessemer steel, it is always put into the ladle. In the manufacture of crucible steel castings, the ferrosilicon or silicospiegel is put into the crucible in the proper percentage required for the purpose, and melted with the steel. Ferrosilicon is used by iron-founders where a soft fluid and solid casting is desired, and also where a large quantity of scrap or hard pig-iron is used containing a low percentage of silicon. The ferrosilicon is usually mixed and melted with the pig-iron in the cupola, and the quantity used varies from 2 to 5 per cent., and in case of hard iron even 10 per cent.

For steel castings it is found that the higher the percentage of silicon in the ferrosilicon and silicospiegel used, the more satisfactory the result.

Analysis of ferrosilicon, made at Ayresome Iron Works, Middlesbrough.

	Per cent.
Iron.....	84.39
Carbon.....	1.40
Manganese.....	2.10
Silicon.....	12.05
Sulphur.....	0.01
Phosphorus.....	0.04
Arsenic.....	trace
Copper.....	0.01
	100.00

Analysis of silicospiegel, made at Ayresome Iron Works, Middlesbrough.

	Per cent.
Iron.....	67.05
Carbon.....	1.39
Manganese.....	19.25
Silicon.....	12.25
Sulphur.....	trace
Phosphorus.....	0.05
Arsenic.....	trace
Copper.....	0.01
	100.00

GJERS' PATENT SOAKING PITS.

[Mr. Gjers' method of treating steel ingots.]

The system is briefly as follows: A number of upright pits (the number, say, of the ingots in a cast) are built in a mass of brickwork sunk in the ground below the level of the floor. These pits are commanded by an ingot crane, by preference so placed in relation to the blooming mill that the crane also commands the live rollers of the mill. Each pit is covered with a separate lid at the floor level, and

after having been well dried and brought to a red heat by the insertion of hot ingots, they are ready for operation. As soon as the ingots are stripped (and the molds should be removed as early as possible) they are transferred one by one, and placed separately by means of the crane into these previously heated pits (which Mr. Gjers calls "soaking pits"), and forthwith covered over with the lid, which practically excludes the air. In these pits, thus covered, the ingots are allowed to stand and soak; that is, the excessive molten heat of the interior, and any additional heat rendered sensible during complete solidification, but latent at the time of placing the ingots into the pit, becomes uniformly distributed, or nearly so, throughout the metallic mass. No heat, or comparatively little, being able to escape, as the ingot is surrounded by brick walls as hot as itself, it follows that the surface heat of the ingot is greatly increased; and after a space of from 20 to 30 minutes, according to circumstances, the ingot is lifted out of the pit apparently much hotter than when it went in, and is now swung round to the rolls by means of the crane in a perfect state of heat for rolling, with this additional advantage to the mill over an ingot heated in an ordinary furnace from a comparatively cold, that it is always certain to be at least as hot in the center as it is on the surface, and the heat is perfectly uniform. Much more, of course, needs to be said fully to describe this process and its advantages, but a careful study of the model, along with the brief hints given, will make the general principle sufficiently clear, and to those who are most interested in these matters the advantages of the process will be obvious. The operation of steel-making on a large scale is hereby very much simplified. A large number of men, some of them highly paid, are dispensed with, and the costly heating furnaces and gas generators so costly also in their maintenance are done away with. A saving is effected of the coal used in heating and still more in yield of steel, which in the heating furnace is very much wasted; moreover, the spoiling of steel by overheating in furnaces is completely done away with. Eminent experts and practical men, who had not only examined the process but carefully tested it in practical working, and that over a considerable period of time, speak of it in the highest terms, and it seems certain to work quite a revolution in the steel industry. We need only say further that the underground position of the soaking pits offers the best facility for handling the ingots with economy in labor, and, as an inspection of the model will show, there is no running the ingots about as is usually the case in steel works; they are lifted by one crane to another and directly into the pits. The cranes lift, swing, and rack in and out by hydraulic power, so that very little labor is required except what is needful for putting the dogs on to the ingots and remove and replace the lids.

W. F. Durfee states, in the Iron and Steel Bulletin, that the amount of steel passing through the Gjers' soaking pit was, in tons:

Country.	1887.	1888.
Great Britain.....	237,546	257,335
Germany.....	153,454	227,020
Austria.....	90,000	95,000
Belgium.....	68,162	67,377
France.....	8,223	22,558
Sweden.....	4,348	4,578
United States.....		38,660
Total.....	561,733	712,528

SOCIÉTÉ ANONYME DES FORGES DE FRANCHE-COMTE, BESANÇON
(DOUBS), FRANCE.

Founded 1853. Capital 18,741,500 francs. Number of workmen, 4,000. Produce iron and steel in blooms, bars, plates, and wire; axles, wheels, nails, tacks, rivets, etc.; iron wire coated with copper, tin, and zinc; tinned wire, 1,000 metres to the kilogramme; chains without welding, and angle iron. Product, about 70,000 tons of all kinds.

SOCIÉTÉ DES CHÂÎNES EN ACIER SANS SOUDURES.

Process Oury.

An ingenious method of producing chains of all sizes and forms of steel without welding. These are made of fine rolled steel bars, a transverse section of which has the form of a cross, with arms of equal length. By machine punches, presses, and drills these bars are divided into the links of the chains. The government test shows increased strength over chains of same caliber of iron. The cost of production is said to be less than of those of iron.

SOCIÉTÉ DES ACIÉRIES D'ALEXANDROWSKY, ST. PETERSBURG, RUSSIA.

Founded in 1879 by a French company. Six hundred workmen. Six Siemens-Martin furnaces, 8 tons each, with neutral lining; one Siemens-Martin furnace, 13 tons, with acid lining; rolling mills, reheating furnaces, etc.

Product, 17,000 tons of ingots per annum; 10,000 tons of plates, bars, shapes, axles, wheels, tires, etc.

The premium offered by the government, together with the import duty, afford a protection to the works of 166 francs 50 centimes per ton of product.

SOCIÉTÉ ANONYME DE MÉTALLURGIE ET CONSTRUCTIONS, VIZCAYA.
SESTAO, NEAR BILBAO, SPAIN.

Founded 1882. Capital 12,500,000 francs. Two blast furnaces, put in blast 1885; one blast furnace in construction; three Siemens-Martin furnaces, 12 tons each, commenced production May, 1889; one Siemens-Martin furnace in construction; seventy-two coke ovens in use 1885, system Carves, with utilization of by-products; seventy-two coke ovens in construction; rolling mills in operation June, 1889.

Product per annum, 150,000 tons of minerals; 60,000 tons of coke and by-products of tar and ammonia sulphate; 85,000 tons of hematite pig-iron, and 18,000 tons of soft steel.

About 50,000 tons of pig-iron have been exported per year.

This company received a grand prize.

ZINC.

LA SOCIÉTÉ DE LA VIEILLE-MONTAGNE.

From a pamphlet published by this society, the following statements are extracted:

The calamine deposits at Moresnet, Duchy of Limbourg, in Belgium, are the most famous and the oldest worked mines of this mineral mentioned. From the beginning of the middle ages this ore was taken thence for the production, in mixture with copper, of brasses. Orichalcos was manufactured by the ancient Greeks and, no doubt, the secret of its manufacture had reached Belgium through Germany. Under date of July 5, 1435, there is mention made of the concession of a mine of zinc by the duke of Limbourg. In one account of 1439, they mention the mountain of calamine, "which those of Aix had the habit of working." This mine, then abandoned, must have gone back to a far distant period. On account of this circumstance, this calamine deposit had received later the name of "Vieille-Montagne" (Altenberg).

In 1454 the mine was reopened, after the grant had been given by Philippe le Bon to Arnold Van Zevel. This mine, which must have had so long an existence, was from that time on the most esteemed for the abundance and quality of its products. The ore was calcined on the spot with charcoal from the forests of Hertogenwald, and carried to the different localities where copper was worked. It was in use at Aix, Stolberg, and Cornelius-Munster, but the manufacturers of brass of Dinant, Bouvignes, Oignies, and other localities of the county of Namm bought the greater part of the production and had it transported toward their factories, first as far as Viol and afterwards utilizing the water courses of the Meuse and the Sambre. It is known that they obtained brass by mixing in crucibles cala-

mine and coal with red copper from the Tyrol. Then they transformed the cast or hammered brass into objects of all kinds, of which the existing specimens attest a true art sentiment of the authors.

Under the Dukes of Limbourg and of Burgundy, as well as under the Spanish dominion, the mines of this region of Moresnet were sometimes conceded temporarily, leased to private parties, never exceeding 12 years, and sometimes worked for the account of the government by its functionaries. This last system was notably used under the Archduke, Albert and Isabella, and later in the time of Philip IV, King of Spain. In imitation of the Spanish sovereigns, the Austrian Government practiced sometimes the leasing, and sometimes administration. After the annexing of the Belgian provinces to France, in 1795, the Republican Government worked the mine of Vieille-Montagne for the good of the nation; but this system soon brought a great decline in the working. The Imperial Government renounced it and, in 1806, conceded the mine to the Liege chemist, the abbot Daniel Dony, with "the obligation of making proofs, which could be recognized as useful, of his ability to reduce, by aid of appropriate furnaces, calamine to the metallic state." Thus the Emperor, in a manner, ordered Dony to discover zinc, and although discoveries are rarely made by order, Dony obeyed and discovered zinc. It is known that chance had in this invention, like many others, as great a part as science and the perseverance of man.

The anecdote is classical; Dony tried to melt the calamine in a reverberatory furnace. Supposing the mineral was not sufficiently fusible to produce the desired reaction, he had the idea of mixing it with coal direct. Then, so as to observe what took place in the apparatus, he adjusted in the edge of the furnace a flower-pot, which projected in front of the masonry. What was his surprise to see soon, through the little hole in the bottom of the pot, the zinc condense in drops in that form of prolong, colder than the oven. The method of reducing the mineral of zinc was found, and one of the great modern industries was to come from that little workshop of the faubourg St. Leonard at Liège, where Dony had installed his rudimentary furnaces. The first step was taken; but in spite of the proverb, it was not that one which was to cost the most. It was not sufficient to have invented zinc, it was necessary also to find the means of using it; it was necessary to give the public the desire and the idea of utilizing it; it was necessary to raise the new comer to the rank of necessary metals. One man alone could not suffice for this task. Dony ruined himself and died without having accomplished it.

Dominique Mosselman succeeded him, in 1818. He was a man of rare energy. He consecrated his life to perfecting the manufacture of the new metal and to finding for it a market. But, nevertheless,

at his death, in 1837, this industry scarcely existed save in expectation. To mobilize his estate, his children founded the stock company of "Vieille-Montagne," with a capital of 7,000,000 francs, divided into seven thousand shares of 1,000 francs each.

The patrimony of Mosselman's heirs, which constituted the property of the new company, comprised the calamine mine of Moresnet, the zinc foundry of St. Leonard at Liège, two small rolling mills at Hom and Houx in France, and, finally, the factory at Angleur, on the borders of the Ourthe, then in course of construction. A few months later the company bought the rolling mills of Bray, in France, and of Tilff, in Belgium. Managed by two directors, one residing in Paris and the other in Liège, the company had a laborious beginning, and developed slowly, notwithstanding the efforts of eminent administrators. In 1846 the direction of affairs was confined to St. Paul de Sincay, who still manages them. From that moment the new company made a rapid advance.

In 1853 it absorbed the Companies of Rhenish Prussia, of Valentin-Cocq, and of the Meuse; added to its Belgian establishments the manufactures and coal mines of Valentin-Cocq and of Flöne; planted itself in Germany, with its mines of the district of Bensberg, its foundries at Bensberg and Mülheim, and its rolling mills and furnaces for roasting the blende of Oberhausen. In 1855 the Company for White Zinc disposed of all its property to this company, chiefly consisting of the factories for white at Brussels, at Levallois-Perret near Paris, and at Colladios. In 1857 the company, realizing the future for the treatment of blendes heretofore regarded as useless, purchased in Sweden the vast beds of the district of Ammeberg, near Lake Wetteren. The same considerations determined them in 1889 to build large works for roasting blendes near Antwerp, on the canal of Campine. In 1871 the great discoveries of zinc ores in the Mediterranean Basin, which menaced the equilibrium of this industry, decided the company to purchase and develop a new center of production in France, at Viviez, and a rolling mill at Panchot; of assuring to itself, by deeds of purchase and by exploitation in shares, the product of important mines in Sardinia, in the district of Iglesias. After having obtained in Algeria the concession of Hamman, it has endeavored to extend there constantly its mining property in the interest of its French factories. In 1883 it bought in the Gard and the Hérault the mining concessions of the "Société des Zinc Français," in liquidation. Finally, in 1887, it has completed its facilities in France by acquiring in the department of the North, in the proximity of its reduction works, the rolling mill of Hautment. By its situation in the center of a net-work of communications by water and rail this establishment is destined to render great services to the important French customers of the company.

The "Vieille-Montagne" possesses twenty-one large establishments,

centers of administration of commerce and of metallurgical and mining production, disseminated in Belgium, France, Germany, Sweden, Sardinia, Spain, and Algeria. It has 250 technical and administrative employers and 6,500 workmen, not including those engaged in contract work. The salaries and annual payments amount to more than 8,000,000 francs. Its steam and hydraulic motors aggregate 4,500 horse-power, and are one hundred and eighty-five in number. In 1888 it sold 62,000 tons of zinc of all descriptions, cast, rolled, and oxide. It is so constituted as to its mines and manufactures that it can produce this large quantity, constituting an important part of the total production.

Notwithstanding the considerable amount of business indicated, the capital stock is only 9,000,000 francs, represented by 112,500 shares of a par value of 80 francs each. From time to time there has been issued 14,800,000 francs of bonds, of which 1,763,500 francs have been redeemed. The balance will be redeemed in 1892. Up to the end of 1888 the reserves of this company amounted to 43,648,613 francs. Since its origin it has paid annually in dividends an average of 20 per cent.

The Vieille-Montagne, the first in date, has remained the first in importance of the companies producing zinc ores. By its initiative it has largely contributed to the progress of this branch of mining industry. Its principal deposits—those of Moresnet for calamine, and those of Bensberg, on the Rhine, and Ammeberg, in Sweden, for blende—have become, in a manner, classical. More than 2,000,000 tons of ore have been produced by the first named. It is the most important of central Europe. In the north bed silicate of zinc is abundantly found, from which zinc almost chemically pure is made. The Sardinian mines have produced large quantities of good calamines.

The furnaces used are of two types—the Belgian and the Silesian. The Belgian was originally constructed with sixteen to twenty retorts, producing 200 kilogrammes of metal per 24 hours. In 1840, by uniting the furnaces by fours, the production increased to 250 and 300 kilogrammes. At the present time, with the same number of workmen and consumption of coal, the furnace of Anglem produces 1,300 to 1,400 kilogrammes. At Valentin-Cocq, the greatest zinc works of Europe with the Silesian system, the production is about the same. At Viviez gas stoves with a blast of air are used, whereby inferior coal is utilized.

In the manufacture of the retorts and fire-bricks the materials are pulverized, mixed, and kneaded by machinery, and subsequently by a machine formed into retorts. At some of the works a hydraulic press is used, especially adapted for the manufacture of the Silesian retort. These machines produce six times as many retorts of a superior quality with fewer workmen.

The ore is pulverized by the Vaport crusher, which crushes 12,000 kilogrammes per hour. The mixtures are transferred by machinery to the furnace fronts.

Uses of cast zinc produced by this company.—Zinc extra pure, made from the Moresnet mineral, is almost chemically pure, and is used for the manufacture of brass for cartridge-cases. The English and Russian Governments require very pure zinc, which has been obtained from the United States, from the Bergenport and Bertha Works. Vieille-Montagne now manufactures a zinc superior to these at a lower price, containing less than half a thousandth of foreign matter. The French Government has given important orders for this metal.

Zinc, called art cast, used for imitation bronze in Paris.

Zinc for brass-making.

Zinc for galvanizing: It is estimated that England alone consumes 35,000 tons per year for this purpose. England and Germany have long had a monopoly of this business. Other uses are for the numerous special alloys, as delta metal, white metal, etc.

Rolled zinc: The uses of rolled zinc are very numerous and increasing every day. The most important is for roofing, 6 to 7 kilogrammes per square metre. Slate weighs 25 kilogrammes for same area. A zinc roof properly laid will last indefinitely. The roof of St. Barthelemy at Liège dates from 1811, and is still in good condition. Special pamphlets upon this subject are published by the company. They have introduced the use, also, of shingles of zinc. Over 10 hectares of this roofing was used at the Exposition buildings. The shingles are made of the ordinary form, lengthened and lozenge shape, also with double edges. These are also used for the lining of houses.

Channeled zinc is used for temporary constructions and others, and does not deteriorate like galvanized iron.

Rolled zinc is used for sheathing of ships, both wooden and iron. The English Government has applied this to a number of their ships. Rolled zinc has been substituted for cast zinc for preventing the incrustation of steam boilers and the prevention of corrosion. The galvanic action established serves to obviate both of these conditions.

For fastening the rolled zinc upon ships zinc nails are employed, as the iron nails are too rapidly corroded. These nails, which are wrought cold, are used for other purposes, to avoid the staining which iron produces. Other uses are for stamping of cornices and other architectural ornaments, household utensils, vats for breweries, etc., tubes for the ventilation of mines, lining of packing boxes, plates for zincography, leaf zinc for application to wall papers and decoration, perforated zinc for sieves, zinc wire for use when the staining by iron is to be avoided, and elements for electric batteries.

Zinc white: This is all made by oxidizing the metallic zinc, the snow-white oxide being made from the Moresnet zinc. Inferior

qualities are made from ordinary zinc. These are sold in powder and also ground in oil. Germany, Holland, and America use the American process, which does not produce so white an oxide.

Gray stone is a mixture of the refuse zinc oxide and oxichloride of zinc, under the name of metallic cement, used for the restoration of old monuments. The Porte St. Denis, in Paris, has been thus restored.

Stony oxide: Oxide of zinc mixed with potassium silicate furnishes an incombustible paint, called silicate paint. Oxide of zinc is also used for manufacture of India rubber, pasteboard, enamels, in place of minium, in fine colors for artistic painting, for whitening laces, in making wafers, chemical matches, sealing wax for champagne, children's toys, silvering of mirrors, preparing straw hats, children's carriages, paper to cover eatables, white oilcloth, patent leather, artistic basketware, impressions upon materials, porcelain maps, military equipments, etc.

The total production of crude zinc in Europe in 1888 was 271,010 tons. Below is a list of the producers of more than 6,000 tons:

	Tons.		Tons.
Vieille-Montagne	52,446	Société Austro-Belge.....	9,277
Société de Silesie.....	23,261	C. Dumont et frères.. ..	8,890
Héritiers von Giesche.....	17,858	Compagnie Rhin-Nassau	7,700
Compagnie royale Asturienne...	16,383	L. de Laminne.....	6,696
Duc d'Ugest.....	15,688	Vivian & Sons	6,608
Compagnie Stolberg	14,247	Comtesse Schaffgotsch	6,498
Comte H. Von Donnersmark	11,361		

In a table is given the price of spelter from 1837 to 1888, the highest price being in 1842, 82 francs per metric centner and the lowest in 1848, 34 francs per centner; in 1878, 42 francs, and 1888, 46 francs.

A book specially describing the practical work is published by this company.

SOCIÉTÉ ANONYME DES MINES ET FONDERIES DE ZINC ET DE PLOMB
DE LA NOUVELLE-MONTAGNE, BELGIUM.

This company was founded in 1845. Its mines yield zinc sulphides and carbonates carrying lead, and its coal mines furnish the fuel for the roasting and reduction of these ores. The roasting is accomplished in eighteen double hearth Freiberg roasting furnaces, connected with four lead chambers, each of 6,000 cubic metres' capacity, for the conversion of the sulphurous vapors into sulphuric acid. The roasted zinc ores are reduced in Belgian furnaces, the lead contained in the residues from the distillation being recovered by washing. From the rich galenas, the lead is obtained by the roasting and reaction processes, is free from arsenic and antimony and suited for the manufacture of white lead. A portion of the spelter is rolled

for sheet zinc. The crucibles and retorts are made by hydraulic presses.

All the workmen are associated in a bank of relief, which, for a small portion of their pay, furnishes gratuitous medical attention and medicines and pecuniary relief in case of sickness or wounds. The company also contributes largely to this bank.

LOUIS CAHAIGNE ET CIE., RUE ST.-BERNARD, 42, PARIS, FRANCE.

This company exhibited chemically pure distilled zinc, applicable to electricity and all industries.

Photozincography and the manufacture of brass for cartridges has made some demand for a pure spelter. In this country the ore from Friedensville, Pennsylvania, and from the Bertha mine in North Carolina yields a metal quite free from impurity.

FURNACES HEATED BY GAS.

The application of gas for the distillation of zinc has been adopted in various parts of the world, with the advantage of great economy of labor.

In Europe the continuous system has been introduced, in which the air only is previously heated. In this practice the air is forced by a fan-blower through flues of fine clay tiles, placed beneath the benches of muffles, the flues being carried transversely beneath the retorts, and being heated by the waste gases which envelop the flues. The gas is obtained from ordinary producers, similar to those in use for Bessemer works, etc.; the bituminous coal being decomposed upon inclined grates with underlying layer of cinders. The gas is not previously heated, but is delivered into small mixing chambers, beneath each bench of muffles, where it meets the hot air.

Another method is to deliver the gas at one end, beneath the benches, and force in the cold air at different points, in quantities sufficient to maintain the required heat.

A third method is by the use of water gas, produced by the forcing of air and low-pressure steam over anthracite coal, affording a gas of the following composition:

	Per cent.
Carbonic oxide	23 to 26
Carbonic acid	1 to 3
Hydrogen	15 to 12
Marsh gas	1 to 2
Nitrogen	60 to 57
Total.....	100 to 100

Both the gas and the air are heated in Siemens' regenerative chambers, placed beneath the benches of muffles, the air being forced by fan blowers and the steam passing into the gas produces with

the air necessary to the maintenance of the oxidation of the coal. The pressure is equal to 2 to 3 inches of water pressure. In the Belgium system of muffles, the muffles are in three tiers only, and in the Silesian system, as usual only one tier of muffles. By the use of gas the economy of labor is very great.

COPPER.

SOCIÉTÉ MÉTALLURGIQUE DU CUIVRE, ÉQUILLES (VAUCLUSE),
FRANCE.

Process, Manhes. Received a gold medal.

There is no metallurgical operation which consumes, relatively to the quantity of metal produced, so large a proportion of fuel as the reduction of copper ores, and for this reason this branch of metallurgy has quite exclusively been concentrated in Great Britain, at Swansea and Liverpool, where coal can be had at a low price. For a long time they have treated them by the Welsh process, the copper ores coming from all points of the globe.

The Welsh process, a long time in use, consists, according to the nature of the ores, of from six to eight successive operations of roasting and smelting to bring the crude ore to rough copper. All the operations are made in reverberatory furnaces, sometimes combined with cupola furnaces for the production of mattes. No important modification has been made in the Welsh process since its origin, and the metallurgy of copper has remained stationary and has not for a long time made any serious progress.

Percy, Rivot, and Le Play estimate that in this process the consumption of fuel is, at the least, from 16 to 18 tons of bituminous coal per ton of copper produced; such a consumption renders this industry impossible in all countries where fuel is expensive.

In 1878 Pierre Manhes, metallurgist at Lyons, and proprietor of the copper rolling mills at Vedenes (Vaucluse), France, wishing to introduce and establish in France the reduction of copper ores, undertook the study of an economical process, which, by diminishing considerably the proportion of fuel used, rendered this industry possible with advantageous conditions. This study had for its basis the use of the Bessemer converter.

The idea was not new; since 1867 several attempts have been made in this way, but without success, because they had confined themselves to casual experiments without order or preliminary studies. Manhes, on the contrary, established a small experimental works, where, by aid of Paul David as an associate, he undertook a series of experiments which required two years of constant work.

Toward the end of 1880 success was complete, the industrial process absolutely practical, and Manhes, with the coöperation of

friends established the company, the name of which is at the head of this article, and which commenced operations in October, 1881.

The plant consists of six shaft furnaces for smelting the ores, two cupolas for remelting mattes if necessary, six Manhes converters, and four reverberatories for refining.

The Manhes converter differs essentially from the Bessemer converter, such as is usually employed in the metallurgy of iron.

The power for blast, etc., consists of water power and steam power equal to 400 horse-power. Especially established to show the working of the process, these works are, however, capable of treating a large quantity of ores, which may be mined in France, where deposits of copper are not wanting, though hitherto but little mined.

The advantages of the process are the suppression of the roasters, and, by an extreme simplicity, the ore being reduced to copper by two operations:

- (1) A crude smelting of the ore to produce a copper matte.
- (2) This matte is poured into the converter, when, by an energetic oxidation, it is rapidly transformed to rough metal of 98 or 99 per cent. copper.

Iron, sulphur, and other ingredients serve as fuel and maintain the high temperature necessary.

The operation in the converter lasts 30 to 40 minutes and is easy of execution. The metal is refined in a reverberatory furnace.

According to Percy, Le Play, and Rivot, the consumption of fuel in the Welsh process is from 17 to 18 tons per ton of copper, and the hand labor from 65 to 70 francs. In these works the consumption of fuel does not exceed $1\frac{1}{2}$ to 2 tons per ton of copper, and the hand labor is less than 25 francs. These figures suffice to show what enormous economy the Manhes process realizes, and it is important to add that they are not the result of a few experiments, but of the industrial working in all the works which have applied the process.

Another advantage is the rapidity of execution; instead of the large stocks which are necessitated by the long and numerous operations of the Welsh process, in this process there is, so to speak, no stock of materials in use, as the same day can be obtained nearly all the copper contained in the ores. This process can therefore be applied to the reduction of ores in all producing countries, no matter what may be the cost of fuel.

Many mines of copper are neglected through the difficulty of finding an easy and regular supply of ore. This process, by reducing considerably the rôle of fuel in the metallurgy of copper, by simplifying the operations, permits the pursuit of this industry advantageously in all mining countries. The use of this process has spread in the copper-producing countries, where it tends to replace the older methods of treatment. It is in actual use in the following places, in addition to the works named at the head of this article: Parrot Copper

Company, Butte City, Montana; Vivian & Sons, Swansea, Wales; Compagnie des Usines de Lota, Chili; Société Métallurgique Italienne, Leghorn, Italy; Compagnie des Mines de Røraas, Røraas, Norway; Société des Fonderies de Brastberg, Norway; Société Minière de Jerez Lanteira, Spain. Other works are in course of construction or under consideration in different countries of Europe, Asia, America, and Australia.

Some months since, after long study, Manhes succeeded in applying the same process to the metallurgy of nickel by means of a few modifications. The reactions are the same as in the metallurgy of copper. Iron, sulphur, arsenic, and antimony, the usual impurities of nickel, are rapidly oxidized under the energetic action of the converter, and after a few minutes' blowing one obtains, either by the treatment of the mattes or of the smelting, a crude nickel of 90 to 96 per cent. of pure metal, and the refining of which becomes easy by the ordinary processes. The introduction of the Manhes process in the metallurgy of nickel is under consideration in several works, and it is probable that it will permit a notable reduction in the cost of a metal, susceptible of numerous applications in industry and the arts. The exhibit consisted of models of Manhes converter, both fixed and movable, and series of samples illustrating the extraction of copper and of nickel.

To the foregoing statements, obtained from a pamphlet issued by the company, is appended some extracts from a paper by Professor Egleston, of Columbia College, New York, published in the *School of Mines Quarterly*, May, 1885, describing the works of the Parrot Silver and Copper Company, Butte City, Montana.

The converters are cylinders of sheet iron, 0.60 metre high, rounded at the bottom by a circle 1 metre radius to a flat bottom 0.65 metre in diameter, and terminated at the top by an arch of 0.70 metre radius, to which a spout is attached 50 centimetres in diameter. The greatest diameter is 1.54 metres, and the height 1.44 metre. The lining is a mixture of three parts crushed quartz and one part fire clay, 30 centimetres thick on the bottom and lower part of the sides and 25 centimetres on the upper part; at the spout, 6 centimetres. The tuyères are drilled through the lining while soft; they are 12 millimetres in diameter, are perfectly horizontal 15 to 25 centimetres above the stamped bottom, and eighteen to twenty in number. The wind chest is of cast-iron, placed around the converter above the bottom. The converter, lined, has the capacity of an ordinary oil barrel. The shaft furnaces are 5 metres high and 1 metre in diameter at tuyères, which are three in number. The ores are quartzose sulphides and carbonates, containing 12 to 15 per cent. of copper. Each furnace treats 25 to 30 tons of ore in 24 hours and produces 4 tons of matte, containing 25 to 30 per cent. copper. The matte is remelted in a cupola or run directly from the shaft furnace

to the converter. One and a half to 2 tons are run in, filling the converter 20 centimetres from the bottom. The vessel is turned up and the process conducted as in the Bessemer process. The blast is seldom more than half an atmosphere. Coke is added to increase the heat of the converter. It requires 25 minutes to bring a 40 per cent. to a 73 per cent. matte, and 30 minutes to bring a 73 per cent. to 99 per cent. matte. The converter makes twenty-two to twenty-four blows per day. The matte is poured from the converter into a conical mold, remelted and retreated. The slags are remelted with the ore.

The black copper obtained from the converter contains at least 97 per cent. copper and is refined in a reverberatory furnace. The monthly product is 85 to 100 tons.

When they go directly from the first matte to blister copper, a few hundred pounds of coke are used in course of 24 hours to keep the converter sufficiently hot; but in running low-grade material to bring it up to 72 to 75 per cent., the sulphur generates sufficient heat. In order to give greater fluidity to the scorias, cast-iron containing manganese is added to the first matte. If the work is to be done in one operation, a 70 per cent. matte must be made in shaft furnace from the ore, and much advantage of the process is lost. Whether one or two operations in the converter shall be performed is entirely an economical question. The fuel used per ton of copper produced is 4.7 to 5.2 tons.

By the Welsh method 13 to 16 tons are used.

For works producing 100 tons of copper per month 70 men would be required. The total loss of copper is not over 1 per cent. of the copper used in the mattes.

The use of the process has extended slowly, as it is not often practicable to treat a matte of 33 per cent. copper in a single fusion. There is no difficulty with rich mattes. Arsenic, antimony, zinc, tin, and lead are easily separated by the process; but cobalt, nickel, and bismuth seem to concentrate in the copper.

CHAUDRONNERIE HYGIÉNIQUE.

Bimetallic copper and silver. Ch. Martin & Co., 7, Rue Bleue, Paris. System, Édouard Martin patent.

This table ware and cooking utensils are made from copper sheets coated with silver by "placage," the two metals being rolled together, giving a heavy coating of silver. It produces handsome ware at lower prices than the best electroplate.

This firm also exhibited threads bimetallic of steel with copper envelope of great resistance, for use in the arts.

L. Letrange & Co., 1 rue des Haudriettes, Paris, workers in metals, had a fine exhibit of lead, zinc, copper, German silver, bronzes, cupromanganese, and solders in sheets, ingots, etc.

Malleable bronze for cartridge cases is said to have a tensile strength of 112,000 pounds and elongation of 75 per cent.

SOCIÉTÉ ANONYME DU MÉTAL DELTA ET DES ALLIAGES MÉTALLIQUES.

Capital, 1,200,000 francs; works at St. Denis (Seine) and at Liège, Belgium; manufacture metal delta, copper, brass, bronze, and various alloys.

The exhibits comprised ingots, billets, plates, bars, castings, forgings, stampings, tubes, etc. Metal delta is covered by patents of Alexander Dick, a Danish engineer, dated 1883, and subsequent. This company holds the patents for France, Belgium, and Holland. This is said to be an alloy of iron, zinc, and copper. The iron is alloyed with the zinc under a reducing influence, and this alloy is then alloyed with the copper, making an intimate homogeneous mixture claimed to be a chemical combination. It has a specific gravity of 8.4, melts at 950°, has a yellow color, at a dark red heat is as malleable as lead, does not oxidize.

Tests given in their statement:

	Tensile strength.	Elongation.
	<i>Pounds.</i>	<i>Per cent.</i>
Cast	53,200	28
Rolled	86,100	12

The price is given at 13 cents per pound.

The above alloy is probably manganese bronze of copper, tin, and manganese.

MATHELIN AND GARNIER, RUE BOURSAULT, 26, PARIS.

This firm exhibited bronzes and products of same: Phosphor bronze, special process of G. Guillemin. They state that a sample of bronze copper 88, tin 12, zinc 2, had tensile strength 25,000 pounds and elongation of 5 to 7 per cent.; after treatment by their process the tensile strength was 39,000 pounds and the elongation 14 per cent.

The use of phosphor bronzes has much increased. The method of introducing the phosphorus varies. Sometimes the melted alloy is poured upon the phosphorus, placed in a ladle or other vessel, the phosphorus being covered by a perforated piece of refractory earthenware held in place so that the phosphorus may melt and be distributed throughout the mass; or it may be forced below the melted alloy in a sheet iron holder with the same object. The resulting metal is more compact, has a higher tensile strength, and is said to be less attacked by acid-vapors, etc. The phosphorus probably combines with the oxygen dissolved and a small portion may be in combination with the alloyed metals.

Metal Roma is another alloy made by this firm, a phosphomanganese bronze, composition not given; specific gravity 8.50, color of bronze, malleable hot and cold, does not oxidize, not attacked by salt or acidulated water. Tensile strength 49,000 pounds, elongation 29 per cent. These are their statements.

B. H. Cramp & Co., Philadelphia, manufacture manganese bronze, which has been used for the screws of a number of United States war vessels. The alloy used is of the grade Vesuvius manganese bronze. Test made at San Francisco showed elastic limit 28,300 pounds and tensile strength 42,500 pounds. Test made at Zurich, Switzerland, showed:

	Tensile strength.	Elongation.
	Pounds.	Per cent.
Gun steel.....	78,200	14
Common bronze.....	32,700	8
Manganese bronze....	41,240	17

We understand these bronzes to be all castings. Rolled bars of Cramp's bronze showed elastic limit of 86,100 pounds, tensile strength 100,551 pounds, elongation 25 per cent.

I am unable to give the composition of this bronze; of another make the following composition has been furnished: Copper 88, tin 10, zinc 2, manganese 1½ to 2.

ESCHGER, GHESQUIÈRE ET CIE., BIACHE—ST.-VAAST (PAS-DE-CALAIS), FRANCE.

Works for the treatment of minerals of copper, argentiferous copper, and auriferous-argentiferous copper; of lead, argentiferous lead; auriferous-argentiferous lead; of silver and gold; of auriferous and argentiferous zinc; and of gold and silver alloys.

The annual product here is:

	Tons.
Copper.....	4,000
Zinc.....	200
Lead.....	600
Silver.....	35
Gold.....	0.5

There are rolling mills, hammers, etc., for working the metals into various forms. Copper, brass, German silver, and bronzes, in form of ingots, plates, rods and wire, lead and zinc in plates. Tubes of various kinds, copper apparatus for various industries, moneys of copper, bronze, nickel, silver, and gold, moneys to the amount of 239,000,000 francs have been produced here.

At Ougree, Belgium, another works of this company produces 4,500 tons of zinc annually. Here in 1866 they applied electricity

for the recovery of a portion of the useful metals which had passed into the residues.

ELECTROLYTIC PROCESS FOR REFINING COPPER.

We mention here this process which has come somewhat largely into use for producing pure copper for electrical purposes. The impure copper is cast in slabs and suspended in a solution of copper sulphate in water, 2 pounds to the gallon, acidified with one-half pound sulphuric acid. Thin sheet copper forms the cathodes, which are placed about 2 inches from the anode of impure copper. They reach to within 4 inches of the bottom of the tanks, leaving the space in which the impurities settle. The tanks are of wood lined with lead, which is protected again by matched boards. These tanks are 4 feet by 10 feet by 3 feet 6 inches deep, and arranged on different levels, so that the solution flows by siphon from bottom of one to top of the next and prevents the separation into layers. The two conducting rods are placed on one side, and upon these the cross rods of copper for supporting the anodes and cathodes rest. The impurities pass first into solution, except silver and gold, which fall with the mud in the bottom. The copper is deposited upon the cathode. The cost of refining copper by this method is estimated by Fontaine at £6 per ton.

This process is in use in several establishments in the United States.

SOCIÉTÉ ANONYME DES MINES ET FOUNDERIES DE PONT-GIBAUD.

At Coueon (Loire-Inférieure), France. Founded 1853. Capital, 7,000,000 francs.

Lead smelting works in which ores from Sardinia, Spain, and mines of Pontpeum, near Rennes, are worked. The lead is desilverized by the zinc process. Product, 14,000 tons of lead and 20,000 kilogrammes of fine silver per annum. They make 5,000 tons of lead and tin pipe, 3,600 tons of sheet lead, 3,600 tons of shot and bullets, 3,000 tons of white lead, and 2,000 tons of red lead; of copper, 3,000 tons of ingots, 3,000 tons of sheets, 1,000 tons of wire and bars; of brass, 3,000 tons of sheets and 1,200 tons of bars and wire; at Pont-Gibaud (Puy-de-Dôme), smelting works for argentiferous lead ores and other ores of silver and gold. The works are capable of producing 5,000 tons of lead and 12,000 kilogrammes of fine silver per year. Since 1853, 47,800 tons of lead and 162,500 kilogrammes of silver have been produced here.

The ore of the mines of Pont-Gibaud and Auzelles is galena with some iron pyrites and blende. It contains 46 per cent. lead and 1.65 kilogrammes silver per 1,000 kilogrammes; a ton of lead yields 3.58 kilogrammes of silver. The process of extraction of the silver is by use of zinc.

TIN.

CLEVELAND TIN MINING COMPANY, DEADWOOD, BLACK HILLS,
DAKOTA.—HARNEY PEAK TIN MINING COMPANY, BLACK HILLS,
DAKOTA.

These companies exhibited tin ore, cassiterite in quartz, and received bronze medals. In regard to the tin deposits of the United States, we append an extract from the Transactions of the New York Academy of Sciences, March, 1889, a discussion by Prof. J. S. Newberry of Columbia College:

The description of the tin deposits of North Carolina given by J. H. Furman has interested me exceedingly, from the parallelism it shows between the structure of that region and that of the tin-bearing districts of the Black Hills and other portions of the world. Tin is a metal that is very sparsely distributed. The great masses brought from Tasmania, shown at the Centennial Exhibition, were quite phenomenal, and it is not at all surprising that we do not find it in such masses here. It is still an open question whether tin can be profitably worked in the Black Hills; the quantity is enormous, and yet it remains to be seen whether metal enough can be got out of each cubic yard of those great veins to pay the cost. Certainly the conditions in North Carolina seem to be much more favorable.

The tin that has come to us from various parts of the world has all been taken from surface deposits, except that of Cornwall; there it has been regularly mined as iron and gold are mined; but all the tin brought from the island of Banca, from the Malay peninsula, and from Australia, is obtained by the working-over of gravel. The granite containing it has been largely carried away, and what remains is decomposed, so that the tin is obtained by washing. There, too, labor is very cheap. The Chinese do well at placer mining where Americans would starve.

I do not know whether we can ascertain how large a quantity of material has been taken from King's Mountain by erosion; but further north in the Alleghanies the rocks have been very largely removed. Where erosion has been less active, the rock has been rotted down to a depth of 30 to 60 feet, just as Professor Agassiz tells us that in Brazil the rocks are sometimes decomposed to the depth of 150 feet. If any such decay has affected the tin-bearing rocks of North Carolina, the ore could be cheaply worked out, if sufficient water were to be had.

I think we owe a great debt to Mr. Furman for his discovery, and for the very lucid description he has given us. That it is a true tin deposit there can be no question, but just how much it will be worth to us is a question.

This is a very different affair from the so-called tin-stone that was brought here from Virginia three or four years ago. A hundred pounds of it was sent to me, and we had it analyzed in the School of Mines, but never got any tin from it. Other parties have claimed that they found in it 20 per cent. of the metal. I have seen certificates from those who profess to be assayers, claiming large returns of tin from this rock. I do not believe that there is any tin in it at all. But this is a real tin deposit, and it may be that it will prove a productive one. I would like to ask about the water there.

Dr. LEDOUX. There is plenty of water in the creek 100 feet below, that being the watershed where the vein is.

The PRESIDENT. The lack of water may be a difficulty. I should like it if we could get there a head of 500 feet of water, as they do in California, where they cut

down gravel banks 100 feet high and make a handsome profit from gravel, of which a cubic yard will yield but 10 cents.

In this connection, I have to show you a very different style of tin ore which comes from Zacatecas, Mexico. One of our old students, Mr. Banks, has just come back from there, bringing many specimens and having examined a considerable territory. In that region there is some stream tin, but not like that found elsewhere. Generally it occurs in drops and knobs, with a fibrous internal structure, and the masses are of concretionary character. This is different; for it is distributed irregularly through a rhyolite rock that has been evidently very much digested with hot water. The quantity is often large, and yet there, as elsewhere, it is a problem whether there is any deposit that can be worked with profit. I think the general impression has been that it would not pay to do regular mining there. Probably the only way to obtain tin profitably is to employ the natives to wash it out, working the deposit as a placer.

Tin is not nearly so rare a material as it has been said to be. Lumps of cassiterite are often found in the gold gravels of Idaho, and there are veins of tin ore in the Temescal mine near Los Angeles, California: but Mr. Stokes spent a year there, and, after fairly testing the deposit, he came to the conclusion that it would not pay to work it. So we are not so very destitute of tin in North America, but the conditions for the profitable mining of it are peculiar. It must be where, if possible, nature has decomposed the rock; then labor must be cheap, if we are to come in competition with the sources of supply in Tasmania and elsewhere. The conditions described to us by Mr. Furman in North Carolina would appear to be favorable, and it seems as though the chances were better for working the deposits there than in other places.

In regard to the Black Hills, we have had a great variety of testimony. Mr. Bailey, who was one of the first heralds of the great deposit of tin there, has told his story in this room. He brought before the Academy a splendid series of specimens, and claimed that the deposits of tin from which they were taken were unparalleled; but, though that was several years ago, no tin has yet come to market from that region, even after the expenditure of much money and mining on a large scale. The attempt has not yet been a success there. This North Carolina deposit promises better than any I have known elsewhere in this country; and yet I think it a matter of doubt whether the rock can be worked with profit. The mass before us is an unusually rich specimen of ore, and there is tin enough in it to pay for crushing and washing; but a great deal of that sort of work is often done by nature; almost all gold mining depends for its success upon decomposition of the rock. The gold-bearing rock has been made ready for the hand of the washer by natural processes, otherwise it would not pay to work; and the same is generally true of tin.

NICKEL.

The most important exhibit of nickel ores was by the French Mining and Smelting Company "Le Nickel," whose mines are in New Caledonia, and in regard to whose operations some account will be found further on. Their ore is a hydrous silicate of nickel and magnesia, quite free from deleterious impurities. The same ore was also exhibited in the French colonial section from the same locality. In the Norwegian section the Ringerige Nickel Mines and Works in southern Norway exhibited their ore, a niccoliferous pyrites containing 3 to 5 per cent. nickel and cobalt. In the section of the United States the Oregon Nickel Company exhibited their ore. The Can-

adian Copper Company operate mines at Sudbury, Ontario, producing ores containing $2\frac{1}{2}$ to $3\frac{1}{2}$ per cent. of nickel and a small percentage of copper. In 1888 they are said to have mined nickel ore equivalent to 200,000 pounds of nickel. They produce a matte of copper and nickel which is shipped to Great Britain and Germany for refining.

Nickel has become within a few years an important metal. Hitherto its chief use was in alloys with copper and zinc in the German silvers, so called, for the manufacture of articles for the table and other purposes and for electroplating. Switzerland, Belgium, Servia, Germany, United States, and Brazil have issued coins of an alloy of copper and nickel. France and other European states have made ball cases for small arms of an alloy of copper and nickel. These consist of an alloy of copper 80 per cent., nickel 20 per cent., with small quantities of aluminium and manganese. This metal is pressed to shape cold and filled with lead and constitutes the projectile. It is stated that these projectiles at 100 metres' distance have passed through 70 centimetres of pine plank. The most recent application of nickel is in alloying with iron and steel, producing with the latter alloys of great usefulness, a description of which will be given later in this article.

LE NICKEL, 13 RUE LAFAYETTE, PARIS.

Stock company with capital of 12,720,000 francs. Established 1880. Its mines are located in New Caledonia; its smelting works at Noumea and Thio, New Caledonia; Erdington, England; Kirkintilloch, Scotland; Havre, France; and Iserlohn, Germany.

This company produces mattes of nickel and of cobalt, crude and refined nickel, oxide of nickel and of cobalt. Product in 1888, 10,000 tons of nickel and cobalt ores. In 1889 it will export 20,000 tons, and in 1890 30,000 tons.

The capacity of various works of this company per month is 500 tons of mattes, 200 tons of refined metal. Germany, Japan, and India buy nickel in form of cubes, America in form of grains, China cubes and cakes, and England cakes.

Previous to the discovery of the deposits of nickel ores in New Caledonia, nickel ores were obtained in Norway, Sweden, Hungary, and Pennsylvania. The total consumption of metal was estimated at 400 tons per annum. The ores were poor, from 2 to 4 per cent. of metal, and contained arsenic, antimony, cobalt, and other metals which rendered the process of refining expensive.

The price of nickel was from 12 to 15 francs per kilogramme.

The discovery of the deposits of New Caledonia, and the abundance and richness of the ore, its freedom from arsenic, antimony, cobalt, copper, and sulphur have resulted in greatly lowering the price of the metal, which at this writing is $5\frac{1}{2}$ francs per kilogramme.

The ore is exported 8 to 12 per cent. nickel, and is easily reduced to mattes or casts.

In New Caledonia the ore is smelted in cupola furnaces, 10 metres high, with cold blast, using limestone, Sicilian sulphur, and New Castle (Australia) coke. The product is 8 to 10 tons of mattes per day, containing about nickel 60, iron 25, sulphur 15. The impurities are chiefly silicon and magnesium. Larger furnaces could, of course, be employed. A process of refining mattes, given to the writer by a manufacturer, consists in crushing the matte, mixing with lime and sand, and roasting in a reverberatory furnace; part of the sulphur and iron pass off in the slag, the resulting matte containing 80 to 90 per cent. nickel. Again crush and roast giving nickel oxide. This is ground, mixed with carbon and reduced in crucibles. This metal contains from 97 to 99 per cent. nickel. The refining is carried on in France, at Havre, which is the most important nickel refinery in the world.

CHRISTOFLE & CO., PARIS.

The nickel ores of New Caledonia are hydrosilicates of magnesia and nickel, free from sulphur, arsenic, antimony, copper, and cobalt. The iron is not combined with these but is concurrent in small veins and isolated nodules. There seem to be three distinct types, viz:

(1) Emerald green, compact and hard, containing 18 to 20 per cent. of nickel and 5 per cent. of water.

(2) Yellowish green, more friable, containing 12 to 18 per cent. of nickel and 10 to 15 per cent. of water.

(3) Bluish white, very friable and easy to crush, even beneath the finger, containing 6 to 8 per cent. nickel and 20 per cent. of water.

The ores, as imported into Europe, contain a mixture of these and show an average composition—

	Per cent.
Water.....	22
Silica.....	38
Peroxide of iron.....	7
Protoxide of nickel.....	18*
Magnesia.....	15
Total.....	100

A similar ore is found in Malaga, Spain, but generally with a lower percentage of nickel.

At the works of Christofle & Co., at St. Denis, near Paris, the process pursued is as follows, being either a wet process or by wet and dry processes: the ore, in a coarsely powdered condition, is smelted in a furnace with sulphur, so as to produce a matte containing nickel, iron, and a small percentage of copper in combination with sulphur, the other constituents passing off in the slag. This matte is pow-

* Equivalent to nickel, 14.

dered by means of stamps, vertical millstones, and a ball pulverizer. The pulverized ore is placed in a roasting furnace 10 metres in length, and gradually but slowly advanced from the flue end to the fire bridge, occupying 5 to 6 hours. To insure thorough roasting this roasted matte is passed once or twice through the pulverizer, and each time submitted to the roasting operation. The product is essentially sulphide of nickel and oxide of iron. The gases from the furnace are passed through a room, to deposit any suspended dust, before reaching the chimney.

Treatment by wet process.—The well pulverized and completely roasted matte is treated with hydrochloric acid in earthen jars of a capacity of 100 litres. These jars are placed in a water bath, heated by steam, and inclosed in a wooden chamber, tarred upon the exterior, with a conduit to conduct the gases to the chimney. Scrubbers are interposed to absorb the greater part of the hydrosulphuric and hydrochloric acids which are evolved.

The nickel and iron pass into the state of chlorides, which solution is decanted into large covered wooden tubs. The iron is peroxidized by chloride of lime and precipitated by carbonate of lime, the agitation being produced by an air blast. The whole mixture is transferred to large wooden tanks in which the precipitate settles, and the liquid is separated by decantation. It is then pumped to wooden reservoirs of 25,000 litres capacity; the oxide of iron mud is filtered and the filtrate added to the preceding.

The precipitation of oxide of nickel was formerly accomplished by lime water, but owing to the small solubility of lime in water, the volume required was so great that only 25 kilogrammes of oxide of nickel was obtained from these reservoirs. Where very pure oxide of nickel is not desired, milk of lime is used, which permits a larger proportion of the nickel solution. The precipitation is accelerated by agitation. This precipitate is allowed to settle, the clear liquor is decanted, and the precipitate filtered. The wet oxide is dried partly upon a drying floor above the calcining furnaces in which the drying is completed. It is then washed with warm water to remove the lime, and drained upon linen filters.

Treatment in mixed process.—In this process the ore is converted into a matte as in the preceding process; also the matte is similarly roasted, but the roasted matte is treated in a reverberatory so as to separate the major portion of the iron which passes off in the slag. The sulphide of nickel is treated with hydrochloric acid as in the previous process.

Reducing the oxide of nickel.—The damp oxide of nickel, after washing out the lime and dripping, is mixed with flour, or very fine coal, and converted into a homogeneous paste by the action of two cylinders in a trough for the subsequent formation of the cubes or grain nickel, as may be desired. For the formation of the cubes, the

paste is placed in rectangular cases and heated at moderate temperature, 150° to 180° , for a short time so as to compact the mixture. The cake thus formed, about 1 centimetre in thickness, is cut in cubes by knives, and dried in the oven for several hours, until no more water is given off. The cubes are then placed in graphite crucibles with some coal dust; six to eight of these crucibles are placed in a blast furnace, and completely covered with coal. Here the temperature is carried above that required for melting of copper for 6 to 8 hours. This temperature accomplishes the reduction of the oxide of nickel and merely a softening of the metal, so that the cubes preserve their form. This reducing furnace is run continuously for a month without stopping, the crucibles being removed, emptied, refilled and replaced in the furnace. The crucibles last about 8 days.

The crucibles are made from refractory fire clay and plumbago mixed with finely-pulverized graphite crucibles, which have already been used in melting operations. The mixture must have the most complete homogeneity and the crucibles are worked upon the ordinary potter's lathe by means of copper mandrils. They are then dried in the air for a long time, and then placed in a moderately warm room for 24 hours. They are 25 centimetres high, 15 centimetres diameter, and will contain 30 kilogrammes of metal. Their cost is 1.50 francs.

This firm are large manufacturers of white metal table ware, which is composed of copper, zinc, and nickel, about 15 per cent. nickel.

In the refining of nickel the Germans have used a small addition of magnesium, Fleitman's method, and the French a small quantity of aluminium added at time of casting. The crude metal sometimes contains oxide of nickel in noticeable amounts, besides carbon and iron.

NICKEL EXTRACTION.

The following is condensed from Mr. Liviche's description of the process of Christofle & Co.

Ores : New Caledonia:

6 to 20 Ni, 5 to 25 H_2O .

Analysis : H_2O 22, SiO_2 38, Fe_2O_3 7, MgO 15, NiO 18, Ni 14.15.

Process either wet or mixed. Ore smelted in low blast furnace with fluxes. Regulus of sulphides of Ni, Fe, Cu. Regulus broken, crushed in rolls, calcined in reverberatory, with low arch, bed 33 feet long, narrow, charge gradually advanced to fire end from flue end, must not clot, lasts 5 to 6 hours; two calcinations, mass crushed before each, product $NiS + Fe_2O_3$.

Wet way.—Digest the last in HCl , stoneware vessels, 20 gallons capacity, producing $NiCl_2 + FeCl_2$; decant into wood tanks. Peroxidize $FeCl_2$ with $CaClO_2$ precipitate by $CaCO_3$ and settle in wood vat. Transfer to wooden reservoir of 5,000 gallons; filter, and wash iron mud. Add washing to last. Precipitate NiO by milk of lime, settle,

draw off clear liquor, filter, dry, calcine, wash out CaO with hot water, drain, mix with flour or powdered charcoal to paste. Heat last 150° to 180° C., cake four-tenths inch thick, divide in cubes, drive out water by heat. Pack in black-lead crucibles with powdered charcoal, heat 6 to 8 hours in ore furnace, six to eight crucibles, temperature of melted Cu. Cubes retain form as Ni.

Mixed method.—Regulus fused in reverberatory with SiO_2 to rid of iron giving purer NiS below slag, tap former out below and dissolve in HCl as before.

Dry method.—Used at St. Denis. Like mixed method, but fuse again in reverberatory, fluxes in proportion to remove last Fe, giving almost pure NiS; oxidize by calcination, and reduce, giving malleable metal.

Mostly used here as alloys. Standard, equal parts Ni and Cu.

German silver for spoons and forks contains 15 per cent. Zn, balance Ni and Cu; this is electroplated. (Proc. Civ. Eng., 89, 559, 1887.)

L'ÉPINE & CO., 64 RUE DE TURENNE, PARIS.

This firm manufacture refined nickel goods and articles of steel plated with nickel by "placage." From a pamphlet published by them, a few extracts are here appended.

The metal is refined by processes, devised by Fleitmann, of fusion, rolling, and annealing, whereby it is rendered malleable and capable of being worked in various ways. The elimination of the carbon, without absorbing oxygen, is accomplished by them, their metal showing a purity of 99 per cent. The density of cast nickel is given as 8.3 and rolled metal as 8.6. The fusing point is between $1,800^{\circ}$ and $1,900^{\circ}$ C. The breaking strain is 68 kilogrammes per square millimetre for tempered nickel and 46 kilogrammes for annealed metal. The elongation of tempered nickel is 4 per cent. and for annealed metal 38 per cent.

The high melting point, great tenacity, its resistance to oxidation and the action of many chemicals, its malleability and its great brilliancy when polished render it useful in many economical directions. Its principal use hitherto has been in the production of alloys, white metals, or German silvers, and for use as anodes in nickel plating. These anodes were generally cast, owing to the difficulty of refining the metal and rendering it malleable, and thus increasing the cost.

Among the articles exhibited by this firm are rolled and cast anodes. The former, sold at 7.5 francs per kilogramme, are somewhat more expensive, but dissolve slowly and regularly, whereas the cast anodes by their porosity and lack of homogeneity, more rapidly disintegrate and deposit particles in the bath, giving rise to considerable waste. The cast anodes also contain considerable quantity of carbon, which does not injure the whiteness of the galvanic deposit, but diminishes the content of nickel.

Rolled plates for manufacture of knives, spatulas, knife blades, harness ware, jewelry, etc., sold at 8 francs per kilogramme.

A hammered nickel dish for use in pharmacy, 55 centimetres diameter, 25 centimetres deep, about 7 kilogrammes in weight, and 40 litres capacity. This was wrought from one piece; its retail price was 160 francs.

Nickel wire 0.178 millimetre diameter, at 22 francs per kilogramme; 3 millimetres upward, at 10 francs per kilogramme.

Chemical apparatus, such as evaporating dishes and crucibles, cooking utensils, table ware and jewelry, nickel, plated with platinum, has also been produced by this firm, which would be a useful substitute for that expensive metal. Among other proposed applications is the terminating of the glassblowers blowing tubes with nickel to remedy the staining of the glass by oxide of iron from the blowing tubes.

Nickel-plated steel is produced under the patents of Fleitmann and Witte, who worked this process in 1880, this firm in 1883. A plate of nickel is placed on either side of a plate of soft steel, having rolling properties approaching those of the nickel, the whole is then heated and rolled. The plating is easily accomplished and well done, the proportion of nickel is varied from 2 to 25 per cent. on either side of the iron, for culinary articles 10 per cent. being used. This is used (when the price of solid nickel is an obstacle to its use) for culinary utensils, reflectors for lamps (for which it is suited, as the nickel is less affected than silver), knife handles, helmets, pen-holders, pencil cases, corset steels, preserve cans, table ware, etc. The plating is complete, and the two metals are perfectly welded, and superior to electroplate by nickel, which is porous and permits rusting to penetrate, and its polish is less durable.

Pure nickel or plated is not much worked upon wooden mandrels, but better upon cast mandrels. The metals are stamped well by machine, being smoothed on the lathe after annealing. They also work well under the hammer with proper annealing.

The prices of some of the manufactured articles are appended:

Articles.	Nickel.	Plated.
	<i>Francs.</i>	<i>Francs.</i>
Casserole, 18 centimetres diameter.....	18	10
Sauce pans, 14 centimetres diameter.....	14	9
Coffee pots, filter, 4 cups.....	16	12
Soup tureen, 24 centimetres diameter.....	40	.....
Vegetable dishes, 24 centimetres diameter.....	38	20
Platters, 40 centimetres oval.....	20	11
Crucibles with cover, 10 centimetres diameter.....	6.25	.....
Double spatula, 21 centimetres.....	2.75	.....

Iron sheets, 5 per cent. nickel on each side, per kilogramme 2.80 francs.

Schoellen & Co., Vienna, also manufacture solid nickel goods. Special alloy for spoons: Copper, 45; nickel, 30; zinc, 15.

“LE FERRO-NICKEL,” 17 RUE DU PONT-AUX-CHOUX, PARIS.

Stock company. Capital, 1,500,000 francs. Works at Lizy-sur-Ourcq (Seine et Marne), France.

Under the title of “Fonderie de Nickel et Métaux blancs,” this company was established in 1882, by stockholders of the Company “Le Nickel,” to extend the use of nickel in the arts and increase thus the consumption of this metal. They engaged in the manufacture of white metal and German silver. In 1883 they secured the patents for producing malleable nickel and cobalt and alloys of iron with nickel or cobalt. In 1884 the present name was adopted. In 1885 iron German silver was introduced, an alloy of greater resistance and elasticity, and of reduced cost. In 1886 an alloy of 80 per cent. copper and 20 per cent. nickel, with small quantities of aluminium and manganese, was made for the covering of balls for small arms, for use of the French Government. This metal is pressed to shape cold, and filled with lead. It is a very hard alloy, said to have penetrated, as a projectile, 70 centimetres of pine plank. In 1887 the manufacture of ferronickel was determined upon. This alloy consists of iron 75 per cent., and nickel 25 per cent. This company produces the iron and nickel alloys under the patents of Mr. Marbeau for the “production of ferronickel and ferrocobalt, by the direct employment of pigs or mattes of these metals with ferrocyanide or cyanide of potassium and one of the oxides of manganese, adding at the moment of casting a small quantity of aluminium.” Contrary to the statement made during the discussion of Mr. Riley’s paper, the above alloy is not attracted by the magnet.

ALLOYS OF NICKEL AND STEEL.

In a paper read by James Riley before the Iron and Steel Institute, at Glasgow, in May, 1889, are stated some results of his examination of alloys of nickel and steel, which were brought to his attention by Mr. Marbeau, the patentee, and also president of the Ferro-Nickel Company. A summary is here given: The composition of the metal can be as effectually controlled in the open-hearth furnace as in the crucible, and in as short a time as an ordinary charge of scrap steel, about 7 hours. No extraordinary care, nor any special arrangements for casting are required, and nearly all the nickel will be found in the steel, almost none being lost in the slag. The steel is steady in the mold, is more fluid, sets more rapidly, and appears homogeneous. Any scrap produced can be remelted in another charge without loss of nickel. No extraordinary care is necessary in reheating the ingots for hammering or rolling. If the steel has been

properly made and of the correct composition it will hammer and roll well, whether it contains little or much nickel. As with other varieties of steel, variation of the contents of other elements will exert considerable influence upon the character of the alloy. Up to 5 per cent. nickel the alloys can be machined with moderate ease; beyond that they are more difficult to machine. Up to 20 per cent. nickel has a hardening influence; at this point and beyond the addition of nickel tends to make the steel softer and more ductile, and even to neutralize the influence of carbon.

Compared with ordinary mild steel: Carbon, 0.22; elastic limit, 16 tons; breaking strain, 30 tons; extension, 23 per cent. on 8 inches, and contraction of area, 48 per cent. By the addition of 4.7 per cent. nickel, the carbon remaining the same, the alloy had elastic limit, 28 tons; breaking strain, 40.6; extension, 20 per cent., and contraction of area 44.8 per cent. Similar results followed with only 3 per cent. nickel.

With 25-per cent. of nickel the elastic limit was 15.1 tons; the breaking strain, 42.1 tons; extension, 40 per cent., and contraction of area 43.6. This great extension before fracture, indicating great ductility, is remarkable. The elongation is also nearly uniform throughout the piece.

One sample alloy furnished by the patentee gave breaking strain, 95.6 tons; elastic limit, 54 tons; extension in 4 inches, 9.37 per cent.; contraction of area, 49.2 per cent. The torsion tests were also good.

Nickel steels up to 50 per cent. nickel take a good polish, the color being lighter with increase of nickel. The corrodibility is less than with other steels. Compared with mild steel, 5 per cent. nickel steel corrodes in the ratio of 10 to 12; 25 per cent. nickel steel in the ratio of 10 to 870, which is practically in non-corrodible.

One per cent. nickel steel welds fairly well; but this quality deteriorates with addition of nickel.

Specific gravity nickel.....	8.86
25 per cent. ferronickel.....	8.08
10 per cent. nickel.....	7.866
5 per cent. nickel.....	7.846
Hammered steel.....	7.84

The uses to which these nickel steels may be applied are very numerous. The 25 per cent. nickel steel, or ferronickel, as the patentee calls it, by its great ductility and non-corrodibility will have many applications. Twenty-six thousand metres of wire per kilogramme have been drawn of this alloy. Its electrical resistance is much greater than that of German silver—about threefold. It may be used for small boilers, fire-boxes, and hulls of torpedo boats, requiring lightness, strength, and non-corrodibility, and between 25 and 5 per cent. nickel, may be found tool steel of good quality. With alloys of 5 per cent. and under, the marine and civil engineer

and ship builder will find many useful qualities, the greater strength enabling them to reduce the weight of materials used.

In the subsequent discussion it was stated by J. F. Hall, of Sheffield, who has been experimenting with these alloys, that high nickel steel had been used by him in making gun-barrels with good results.

In reference to the addition of nickel to cast-iron, Mr. Geny stated that the strength of the metal was increased, also its fluidity, resistance, and soundness. Armor plates 6 inches thick have been cast in nickel alloys.

The present writer understands that the Creusot works will submit a 5 per cent. nickel steel armor plate at the coming trial of the United States Navy Department.

Joseph Wharton, of Philadelphia, Pennsylvania, exhibited alloys of nickel and tungsten, an examination of which by Prof. John Trobridge and Samuel Sheldon, of Cambridge, Massachusetts, shows an increase over nickel in specific magnetism when magnetized to saturation. The nickel was of Mr. Wharton's manufacture, about 99 per cent. nickel. The results were as follows:

Bars rolled from cast ingots.

Nickel.	Tungsten.	Specific magnetism.
100	0	1.23
97	3	10.60
96	4	10.40
92	8	5.25
Tool steel.		7.46

Bars cast, not rolled.

Nickel.	Tungsten.	Specific magnetism.
100	0	1.05
99	1	1.92
98	2	1.70
97	3	1.75
94	4	1.15

The specific magnetism of good steel magnets is given as 40.

These alloys will form a useful addition to the resources of physical laboratories.

PATENTS FOR MANUFACTURE OF IRON AND NICKEL ALLOYS.

UNITED STATES PATENT OFFICE.

HENRI SCHNEIDER, OF LE CREUZOT, FRANCE.—PROCESS OF MANUFACTURING THE ALLOYS OF CAST-IRON AND NICKEL.

Specification forming part of Letters Patent No. 415657, dated November 19, 1889.

Application filed December 3, 1888. Serial No. 292520. (Specimens.)

To all whom it may concern:

Be it known that I, Henri Schneider, manager of the firm Schneider & Cie., of Le Creuzot, (Saône-et-Loire,) in the Republic of France, manufacturers, have invented improvements in manufacturing the alloys of cast-iron and nickel, of which the following is a specification.

This invention has reference to the manufacture on a commercial scale of cast or pig iron alloyed with nickel.

Many experiments have heretofore been made with alloys of iron or steel and nickel, and it is known that the addition of a small proportion of the latter metal to the former imparts thereto properties very valuable for certain uses. It is, however, extremely difficult to incorporate nickel with iron and steel, particularly when it is attempted to produce these alloys on a commercial scale. I have discovered that such alloys can be produced by making, as a preliminary product, an alloy or compound of cast-iron and nickel in a crucible, cupola, or open-hearth furnace. This product or alloy, while specially useful for the manufacture of iron and nickel and steel and nickel alloys, may be used for castings for a variety of purposes, and the present application is confined to the production of the cast-iron alloy.

The manufacture of alloys of nickel and steel forms the subject-matter of another application filed December 3, 1888, Serial No. 292518.

In carrying out my invention I charge a suitable furnace with nickel filings or scrap or waste nickel and ordinary cast or pig iron with carbonaceous matter; or the nickel may be in the form of nickelized compounds or coke. The operation may advantageously be carried on in a reverberatory furnace under a layer of anthracite to avoid oxidation. The alloy, which issues as a direct product of the furnace, contains from 5 to 30 per cent. of nickel (though the invention is not limited to these proportions), and is remarkable for its great elasticity and strength, and also for a true tenacity and malleability—properties which may be still further developed by chilling or tempering in well-known ways. The alloys are consequently suitable for use in the manufacture of castings of all descriptions, and to the production of armor-plates, projectiles, and the like.

I claim as my invention—

1. The herein-described process of manufacturing alloys of cast-iron and nickel by charging a suitable furnace with cast or pig iron, nickel, or a composition containing nickel, and melting together, as set forth.

2. The herein-described process of manufacturing alloys of cast-iron and nickel by charging a suitable furnace with cast or pig iron, nickel, or a nickel compound, and carbonaceous matter, with a superposed layer of anthracite, and melting together, as set forth.

3. The herein-described alloy of cast-iron and nickel rich in the latter metal, said alloy being distinguished by homogeneity, tenacity, capacity for tempering, and by the other characteristics set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HENRI SCHNEIDER.

Witnesses:

CHARLES BRÉNOY,
LÉON FRANCKEN.

UNITED STATES PATENT OFFICE.

HENRI SCHNEIDER, OF LE CREUZOT, FRANCE.—PROCESS OF MANUFACTURING THE ALLOYS OF STEEL AND NICKEL.

Specification forming part of Letters Patent No. 415,655, dated November 19, 1889.

Application filed December 3, 1888. Serial No. 292,518. (No specimens.)

To all whom it may concern :

Be it known that I, Henri Schneider, manager of the firm Schneider & Cie., of Le Creuzot, (Saône-et-Loire,) in the Republic of France, manufacturers, have invented Improvements in the Process of Manufacturing the Alloys of Steel and Nickel, of which the following is a specification.

This invention relates to the manufacture on the hearth or bed of a furnace, as hereinafter described, of steel alloyed with nickel, whereby a product is obtained which is employed in the construction of ordnance, armor plates, gun-barrels, projectiles, and other articles for military or other like purposes—commercial sheets or bars, for example. In order to manufacture this combination or alloy of steel and nickel upon a bed or hearth in such a manner as to obtain a homogeneous steel free from flaws or hollows, it is necessary, on the one hand, to avoid oxidizing the nickel before it forms the alloy with the iron, and, on the other hand, it is necessary to cause the incorporation to take place at as early a stage as possible in the operation, or immediately on the commencement of the fusion or liquefaction. This result is attained, according to this invention, by introducing the nickel by the aid of a preliminary melt or mixture in fusion, containing, say, for example, about thirty per cent. of nickel, sixty-three per cent. of iron, three per cent. of carbon, and two of manganese and silicon, this melt being placed on the hearth or bed of the furnace together with a suitable proportion of iron or scrap-steel.

In my concurrent application of even date, Serial No. 292,520, I have described the production of an alloy of cast-iron and nickel. This alloy may be used in the production of an alloy of steel and nickel, either while yet in the molten condition or after cooling and hardening. The alloy of cast-iron and nickel, instead of being formed separately, may be formed in the furnace before proceeding with the subsequent operations, though it is preferred to form it separately. In case it is formed in the furnace itself a bed of anthracite is first prepared in the furnace and the nickel is placed thereon with the requisite proportion of iron or steel. The whole is then covered with anthracite in order to protect the metal from contact with the air during the fusion. When the charge is melted, the excess of anthracite is removed and charges of iron or scrap are added in succession. Waste or scrap steel alloyed with nickel obtained by preceding operations is to be employed in these charges preferably in the first. From this time the operation is conducted on the hearth or open furnace in the same way as in making ordinary steel, care being at the same time taken to continually protect the bath from oxidation by means of a layer of slag or cinder, which is renewed as required, and also to take precautions to prevent redshortness in the metal before the final introduction of the recarbonizing and manganiferous silico-spiegel iron or ferromanganese.

The steel manufactured according to this invention usually contains about five per cent. of nickel—a quantity sufficient to impart a remarkable degree of strength to the product; but the invention is not limited to this proportion.

Steel alloyed with nickel according to this invention is especially adapted or suitable for use in the construction of ordnance, armor plates, gun-barrels, projectiles, and other articles employed for military or other like purposes, or the manufacture of commercial sheets, bars, and the like. The percentages of carbon, silicon, and manganese can be regulated according to the degree of hardness required; but in

all cases, in order to obtain the best result possible, the product must invariably be tempered in an oil or other bath.

I claim as my invention—

The herein-described process of manufacturing a homogeneous alloy of steel and nickel by first forming an alloy of cast-iron and nickel rich in the latter metal, as specified, and charging such alloy into a furnace of the character indicated, with the usual ingredients for the production of steel, and continuing the operation in the ordinary way, as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HENRI SCHNEIDER.

Witnesses:

CHARLES BRÉNOY,
LÉON FRANCKEN.

UNITED STATES PATENT OFFICE.

HENRY MARBEAU, OF PARIS, FRANCE, ASSIGNOR TO THE SOCIÉTÉ ANONYME LE FERRO-NICKEL, OF SAME PLACE.—PROCESS OF MANUFACTURING IRON AND STEEL ALLOYS.

Specification forming part of Letters Patent No. 419,274, dated January 14, 1890.

Application filed April 8, 1889. Serial No. 306,432. (No specimens.)

To all whom it may concern :

Be it known that I, Henry Marbeau, of Paris, in the Republic of France, have invented a certain new and useful Improvement in the Process of Manufacturing Iron and Steel Alloys, of which the following specification is a full, clear, and exact description.

The invention relates to the production of malleable alloys of iron and steel with nickel and other metals.

Heretofore I have obtained ferro-nickels and steel nickels with a high percentage of nickel, varying from ninety-nine per cent. to twenty-five per cent. of nickel, possessing the peculiar properties of the latter metal, such as brilliancy, incapability of oxidation, &c., and which are capable of being substituted for nickel for many purposes. A description of the process of manufacturing such alloys is given in British Patent No. 7,179, dated June 12, 1885. In pursuing experiments in this direction I have now succeeded, by reducing the percentage of nickel below twenty-five per cent., in producing a series of alloys which, although belonging to the same class as those formerly described and patented, are possessed, on account of their constitutive elements and mode of production, of new properties, and constitute a distinct class of alloys, forming a new manufacture.

The present invention relates not to alloys of a relatively high price, which might replace pure nickel, owing to their richness in nickel, but to alloys which may be compared to iron and steel, and in which the addition of a proportion even small of nickel modifies the structure or constitution of the metal without materially augmenting its cost, (for the low percentages,) and produces a remarkable improvement in the quality of the iron or steel employed.

The present invention has for its object the production of malleable alloys of iron or steel with nickel in a proportion varying from about twenty-five per cent. down to a mere trace of nickel, these alloys being capable of being employed in the same way as iron and steel of commerce, but possessing superior qualities to those metals as heretofore obtained.

The new processes consist in simultaneously using manganese and aluminium with or without the addition of charcoal or other form of carbon or metallic cyanides or ferro-cyanides. With regard to manganese, either pure manganese is em-

ployed or oxides of this metal mixed with a reducing agent or ferro-manganese. In the same manner, with regard to the aluminium, either pure aluminium is employed or a mixture of iron and aluminium. The nickel itself is introduced either in the form of pure nickel or in that of a malleabilized metal, or in the form of a matt or speiss more or less rich in nickel, derived from the smelting of metal ores carried on up to the beginning of the elimination of iron or derived from a previous melting of cast or other iron or steel with nickel.

The following is an example of a convenient method of conducting the process in order to obtain a good result: It is preferable to take the nickel pure or alloyed with iron at the first stage of the operation. The manganese, in whatever shape it is used, mixed or not mixed with the carburizing agents, is added, either all at once or in two or more successive additions during the course of the fusion. The necessary proportion of aluminium is thrown in at the end of the operation, either in the melted metal in the furnace or in the casting-ladle. As regards the melting apparatus, any suitable apparatus—such as those used at the present time for metallurgical purposes, crucibles, reverberating furnaces, converters, Siemens furnace, cupolas, and the like—can be employed.

The following may be taken as an example of the proportions which may be employed with good effect; but the invention is not limited to the precise proportions specified: For every thousand parts, by weight, alloy to be produced, take from about one-tenth of a part to about one part of aluminium and from about one to twenty parts of manganese, according to the proportion of nickel and the quality of the product to be manufactured.

With regard to the carburizing agents, the carbon or cyanides are to be used in different proportions, according to the nature of the alloys required—that is to say, according as the alloys to be produced are hard or soft, carburized or not carburized, with the same percentage of nickel. Thus it is by the use of ferro-cyanide with manganese and aluminium, even without the addition of nickel, iron can be transformed into ready-tempered steel, capable of being forged directly into turning-tools without further tempering.

As an example, the proportions hereinafter specified are suitable for making on an open hearth a ferro-nickel with five per cent. of nickel, starting from a nickeliferous melt.

The operation is conducted as in making steel, and after the partial or complete decarburation (according to the quality of the alloy to be obtained) the metallic manganese or ferro-manganese is added, and when the time comes for running, the aluminium is thrown in, either in the open hearth or in the casting-ladle.

In order to make five hundred kilos (or thereabout) of alloy, the following may be used:

	Kilos.
Iron containing twenty-five per cent. of nickel	100
Soft iron or steel	400
Ferro-manganese containing seventy-five per cent. of manganese	3
Aluminium	.250
	503.250

The characteristic points of these different alloys are as follows: They possess a much more perfect homogeneousness than iron or steel obtained by the usual processes, and consequently they have very superior qualities, such as those of malleability, ductility, resistance, and elasticity. The ingots solidify very quickly, and blow-holes are avoided. Ferro-nickels with twenty-five per cent. nickel cannot be tempered whatever may be the proportion of carbon they contain; but in proportion as the quantity of nickel is reduced their capacity for being tempered increases,

and with a percentage of seven, five, and three of nickel and downward alloys are obtained which can be tempered just in the same manner as ordinary steels and according to the same rules.

The percentage of carbon, the distribution and the special forms of carbon in the cement and metallic nucleus, which modifications are due to the presence of nickel, (the cement referred to being the part containing the greater part of the carbon and surrounding the nucleus, which is constituted chiefly by the iron,) the fall of temperature between the heating and cooling, the rapidity of the cooling intervene to produce different qualities of hardness, as could have been foreseen from the complete analysis made according to the very accurate methods recently discovered and from the remarkable discoveries relating to the innermost constitution of the steel which have been made in the last few years.

The influence of the agents of malleabilization in the application of our processes is demonstrated by the fact that even when these agents are used without addition of nickel the products obtained possess qualities by far superior to those of iron and steel made by the ordinary processes.

Heretofore and prior to this invention I have produced ferro-nickel and ferro-cobalt by the direct fusion of pigs or mattes with one of the oxides of manganese and cyanide or ferro-cyanide of potassium, adding at the moment of tapping a small quantity of aluminium. Such process is described and claimed in British Patent No. 2,573 of 1884, granted on a communication from me. That process, however, related exclusively to the treatment of pigs or mattes of nickel and cobalt, whereas the process herein described is particularly applicable to pure or refined nickel. The former process related exclusively to alloys resembling nickel in their properties and containing upward of twenty-five per cent. of that metal, whereas the present invention relates exclusively to alloys containing less than twenty-five per cent. of nickel and from that down to a mere trace, such alloys constituting, as already stated, an entirely distinct class, possessing different and peculiar properties. Moreover, by the present invention a great economy is effected in the agents of malleabilization, and the new process differs radically from the former one in the proportions of these ingredients. I employ, according to the present invention, about one-ninth the quantity of manganese, about one-half the quantity of aluminium, and a much smaller proportion of carburizing agents to the same quantity, by weight, of the alloy.

I claim as my invention—

1. The herein-described process of manufacturing malleable alloys containing iron or steel and nickel by fusing the iron or steel with a comparatively small proportion (less than twenty-five per cent.) of nickel and with manganese and aluminium in approximately the proportions stated, as set forth.

2. The herein-described malleable alloy, composed of iron or steel and nickel, the proportion of nickel being less than twenty-five per cent. of the whole, with manganese and aluminium in approximately the proportions set forth.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

HENRY MARBEAU.

Witnesses:

MAURICE GENZ,

JOSEPH BOURNIER.

ALUMINIUM.

ALUMINIUM COMPANY, LIMITED, LONDON, ENGLAND.

Founded in 1887. Capital £400,000. Works at Oldbury near Birmingham. This company exhibits aluminium and its alloys, sodium and potassium.

They produce sodium and potassium by the patented processes of H. G. Castner, of New York. They have also acquired the patents of James Webster, for the production of pure aluminium and its compounds. Aluminium is produced by the Deville process modified by various improvements. This modified process has been styled by Sir Henry Roscoe, Deville-Castner process.

The exhibits of this company consisted of a block of 98 per cent. aluminium weighing half a ton, and a block of aluminium bronze of the same weight. Also ingots of 99 per cent. aluminum, 5 and 10 per cent. bronze, 10 per cent. ferroaluminium and 20 per cent. aluminium steel. Also aluminium plate, sheets, wire, tubes, statue, cigarette cases, etc.

This company received a gold medal.

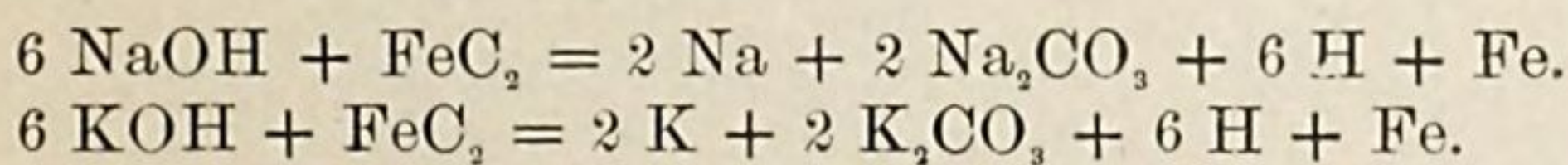
By the old process of making sodium, carbonate of soda, charcoal, and lime in the proportion of 30, 13, and 7 are brought into intimate mixture, calcined at a red heat to render it more compact, and distilled in narrow wrought-iron cylinders at $1,400^{\circ}\text{C}$., the metal passing off as vapor through small tubes to the condenser. Only 40 per cent. of the theoretical product is obtained, in the case of potassium much less, and the wear and tear of the cylinders is very great.

A black compound by the action of carbonic oxide upon the metallic vapor closes the small tubes; in the case of potassium this is explosive, requiring constant attention. The cost is as follows:

	<i>s. d.</i>
Materials, owing to loss	1 0
Wear and tear of furnace, etc.....	2 0
Labor	0 8
Fuel.....	0 4
Sodium per pound	4 0

THE CASTNER PROCESS.

The process for the production of sodium and potassium is represented by the following equations:



The fine iron is produced by passing hot carbonic oxide and hydrogen (water gas) over oxide of iron, commercially known as purple

ore, heated to 500°C . This fine iron is mixed with melted coal tar pitch in proper proportion, the mixture cooled, broken into lumps, and coked in iron retorts. This metallic coke consists of carbon and iron, in proportion similar to an iron carbide, from which the carbon or iron can not be separated by mechanical means. This is very finely ground. The vessels in which the caustic soda and iron carbide are heated are of cast steel, egg-shaped, 18 inches in their greatest diameters, and 3 feet high. They are made in two portions, the lower one in the form of a crucible, and the upper one, secured immovably in the upper part of the furnace, is provided with an upright stem and a hollow protruding arm; attached to the hollow arm is the condenser, which is 5 inches in diameter and 3 feet long, with a hole in the bottom, 20 inches from the nozzle. The bottom of the condenser is so inclined that the metal condensed from the vapor issuing from the crucible, during reduction, flows down and out of the small hole into a small iron pot placed beneath. The condensers at the outer end have a small hinged door, by means of which the workmen may observe the progress of the distillation. The stationary cover has a convex edge, which fits into a groove around the edge of the crucible. A little powdered lime makes the joint tight. The crucible, after receiving its charge of 50 pounds of caustic soda with the proper addition of iron carbide, is elevated by an hydraulic lift into the furnace and against the edge of the cover. The platform of the lift completely fills the aperture in the bottom of the furnace. The temperature of reduction and distillation is about $1,000^{\circ}\text{C}$. The furnace is heated by gas from a gas producer, which is burnt by air previously brought to a high temperature. The time of distillation is 70 minutes. The product is 6 pounds of sodium.

Upon the completion of the distillation the small pots containing the sodium are removed, and, when cool enough, the sodium is covered with high-test petroleum. It is then carried to the casting shop where it is melted under oil in large iron pots, heated by an oil bath, and cast in bars or in sticks.

The crucible is lowered, taken by a large pair of tongs, on wheels, to a dumping pit, the residue cleaned out, a new charge is placed in it, and it is then elevated again into the furnace. There are five crucibles in each furnace, and 7 minutes are required to draw, empty, recharge, and replace them. The works have four furnaces which can produce, altogether, over a ton of sodium in 24 hours.

The average duration of a crucible is one hundred and twenty charges. The residue from the distillation is treated with water to extract the carbonate of soda and the iron is used again to make the iron carbide.

The residue contains—

	Per cent.
Carbonate of soda	77
Peroxide of sodium	2
Carbon.....	2
Iron.....	19
	100

To produce sodium, a little more carbide is used than the reaction requires, and to produce potassium, a little less. The gas coming off in the first part of the distillation is pure hydrogen, and when the operation is nearly completed it contains 5 per cent. of carbonic oxide. In making potassium, owing to the smaller quantity of iron carbide, no carbonic oxide is formed, and therefore there is none of the black compound formed, as mentioned in the first part of this article.

Cost.—The following table of cost, as well as a portion of what goes before, was given in 1887 by James Mactear, in a lecture before the Society of Chemical Industry. It is based upon the results at the old works. The foregoing description relates to the new works, in which the cost is probably reduced:

	£	s.	d.
720 pounds caustic soda, £11 per ton	3	10	10
150 pounds carbide, $\frac{1}{2}$ d. per pound.....		6	4
Labor	1	0	0
Fuel		17	0
Reconverting 624 pounds carbonate into caustic soda	1	0	0
	6	14	2
Deduct value of 475 pounds caustic soda	2	6	8
Cost of 120 pounds sodium	4	7	6
Equal per pound.....			8½
Wear and tear of crucible.....			1
Wear and tear of furnace			1
			10½

This is less than one-fourth the cost by the old process. The cheapness of production by the Castner process is due to the lower heat at which the metal is produced, the quickness of the operation, the less wear and tear of apparatus, the nonclogging of the condensers, and the small waste of materials.

The manufacturing operations for potassium cost no more than for sodium, the higher cost of the caustic potash being the chief element of increased expenses.

The uses of sodium and potassium will doubtless multiply, with their cost so materially reduced. Both sodium and potassium are powerful reducing agents. Aluminium, magnesium, silicon, boron, manganese, and chromium can be isolated by the use of sodium.

Sodium amalgam has been used in the extraction of gold. Con-

siderable quantities are used in the manufacture of antipyrine. It is now sold at 2 shillings per pound.

I introduce here a lecture on aluminium, by Sir Henry Roscoe, M. P., D. C. L., LL.D., F. R. S., delivered at the Royal Institution, London, Friday, May 3, 1889. Professor Roscoe is one the directors of the Aluminium Company:

Chemists of many lands have contributed to our knowledge of the metal aluminium. Davy, in 1807, tried in vain to reduce alumina by means of the electric current. Oerstedt, the Dane, in 1824, pointed out that the metal could be obtained by treating the chloride with an alkali metal; this was accomplished in Germany by Wöhler in 1827, and more completely in 1845, whilst in 1854 Bunsen showed how the metal can be obtained by electrolysis. But it is to France, by the hands of Henri St. Claire Deville, in the same year, that the honor belongs of having first prepared aluminium in a state of purity, and of obtaining it on a scale which enabled its valuable properties to be recognized and made available; and the bar of "silver-white metal from clay," was one of the chemical wonders in the first Paris Exhibition of 1855. Now England and America step in, and I have this evening to relate the important changes which further investigation has effected in the metallurgy of aluminium. The process suggested by Oerstedt, carried out by Wöhler, and modified by Deville, remains in principle unchanged. The metal is prepared, as before, by a reduction of the double chloride of aluminium and sodium, by means of metallic sodium in presence of cryolite; and it is, therefore, not so much a description of a new reaction as of improvements of old ones of which I have to speak.

I may perhaps be allowed to remind my hearers that more than 33 years ago, Mr. Barlow, then secretary to the Institution, delivered a discourse, in the presence of Mr. Deville, on the properties and mode of preparation of aluminium, then a novelty. He stated that the metal was then sold at the rate of £3 per ounce, and the exhibition of a small ingot, cast in the laboratory by Mr. Deville, was considered remarkable. As indicating the progress since made, I may remark that the metal is now sold at 20 shillings per pound, and manufactured by the ton, by the Aluminium Company, at their works at Oldbury, near Birmingham. The improvements which have been made in this manufacture by the zeal and energy of Mr. Castner, an American metallurgist, are of so important a character that the process may properly be termed the Deville-Castner process.

The production of aluminium previous to 1887 probably did not exceed 10,000 pounds per annum, whilst the price at that time was very high. To attain even this production required that at least 100,000 pounds of double chloride, and 40,000 pounds of sodium should be manufactured annually. From these figures an idea of the magnitude of the undertaking assumed by the Aluminium Company may be estimated, when we learn that they erected works having an annual producing capacity of 100,000 pounds of aluminium. To accomplish this required not only that at least 400,000 pounds of sodium, 800,000 pounds of chlorine, and 1,000,000 pounds of double chloride should be annually manufactured, but in addition that each of these materials should be produced at a very low cost, in order to enable the metal to be sold at 20 shillings per pound.

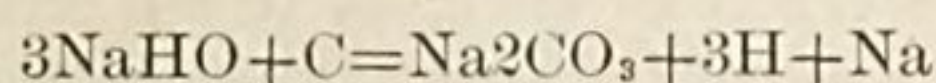
The works now cover a space of nearly 5 acres. They are divided into five separate departments, viz, (1) sodium, (2) chlorine, (3) chloride, (4) aluminium, and (5) foundry, rolling, wire mills, etc.

In each department an accurate account is kept of the production each day, the amount of material used, the different furnaces and apparatus in operation, etc. In this manner it has been found possible to ascertain each day exactly how the different processes are progressing and what effect any modification has either on cost, quantity, or quality of product. By this means a complicated chemical process

is reduced to a series of very simple operations, so that whilst the processes are apparently complicated and difficult to carry out successfully, this is not the case now that the details connected with the manufacture have been perfected and each operation carried on quite independently until the final materials are brought together for the production of the aluminium.

MANUFACTURE OF SODIUM.

The first improvement occurs in the manufacture of sodium by what is known as the "Castner process." The successful working of this process marks an era in the production of sodium, as it not only has greatly cheapened the metal, but has enabled the manufacture to be carried out on a very large scale with little or no danger. Practically, the process consists in heating fused caustic soda in contact with carbon whilst the former substance is in a perfectly liquid condition. By the process in vogue before the introduction of this method it was always deemed necessary that special means should be taken to guard against actual fusion of the mixed charges, which, if it were to take place, would to a large extent allow the alkali and reducing material to separate. Thus, having an infusible charge to heat, requiring the employment of a very high temperature for its decomposition, the iron vessels must be of small circumference to allow the penetration of the heat to the center of the charge without actually melting the vessel in which the materials are heated. By the new process, owing to the alkali being in a fused or perfectly liquid condition in contact directly with carbon, the necessity of this is avoided, and consequently the reduction can be carried on in large vessels at a comparatively low temperature. The reaction taking place may be expressed as follows:



The vessels in which the charges of alkali and reducing material are heated are of egg-shaped pattern, about 18 inches in width at their widest part and about 3 feet high, and are made in two portions, the lower one being actually in the form of a crucible, while the upper one is provided with an upright stem and a protruding hollow arm. This part of the apparatus is known as the cover. In commencing the operation these covers are raised in the heated furnace through apertures provided in the floor of the heated chamber and are then fastened in their place by an attachment adjusted to the stem; the hollow arm extends outside the furnace. Directly below each aperture in the bottom of the furnace are situated the hydraulic lifts, attached to the top of which are the platforms upon which are placed the crucibles to be raised into the furnace. Attached to the hydraulic lifts are the usual reversing valves for lowering or raising, and the platform is of such a size as when raised completely to fill the bottom aperture of the furnace. The charged crucible, being placed upon the platform, is raised into its position, the edges meeting those of the cover, forming an air-tight joint which prevents the escape of gas and vapor from the vessel during reduction, except by the hollow arm provided for this purpose. The natural expansion of the iron vessels is accommodated by the water-pressure in the hydraulic lifts, so that the joint of the cover and crucible is not disturbed until it is intended to lower the lift for the purpose of removing the crucible.

The length of time required for the first operation of reduction and distillation is about two hours. At the end of this time the crucibles are lowered, taken from the platforms by a large pair of tongs on wheels, carried to a dumping pit, and thrown on their sides. The residue is cleaned out, and the hot pot being again gripped by the tongs is taken back to the furnace. On its way the charge of alkali and reducing material is thrown in. It is again placed on the lift and raised in position against the edges of the cover. The time consumed in making the change

is one and one-half minutes, and it only requires about seven minutes to draw, empty, recharge, and replace the five crucibles in each furnace. In this manner the crucibles retain the greater amount of their heat, so that the operation of reduction and distillation now only requires one hour and ten minutes. Each of the four furnaces, of five crucibles each, when in operation are drawn alternately, so that the process is carried on night and day.

Attached to the protruding hollow arm from the cover are the condensers, which are of a peculiar pattern, specially adapted to this process, being quite different from those formerly used. They are about 5 inches in diameter and nearly 3 feet long, and have a small opening in the bottom about 20 inches from the nozzle. The bottom of these condensers is so inclined that the metal, condensed from the vapor issuing from the crucible during reduction, flows down and out into a small pot placed directly below this opening. The uncondensed gases escape from the condenser at the farther end and burn with the characteristic sodium flame. The condensers are also provided with a small hinged door at the farther end, by means of which the workmen from time to time may look in to observe how the distillation is progressing. Previous to drawing the crucibles from the furnace for the purpose of emptying and recharging, the small pots, each containing the distilled metal, are removed and empty ones substituted. Those removed each contain on an average about 6 pounds of metal, and are taken directly to the sodium casting shop, where it is melted and cast either into large bars ready to be used for making aluminium or in smaller sticks to be sold.

Special care is taken to keep the temperature of the furnaces at about $1,000^{\circ}\text{C.}$, and the gas and air valves are carefully regulated, so as to maintain as even a temperature as possible. The covers remain in the furnace from Sunday night to Saturday afternoon, and the crucibles are kept in use until they are worn out, when new ones are substituted without interrupting the general running of the furnace. A furnace in operation requires 250 pounds of caustic soda every one hour and ten minutes, and yields in the same time 30 pounds of sodium and about 240 pounds of crude carbonate of soda. With the four furnaces at work 120 pounds of sodium can be made every seventy minutes, or over a ton in the twenty-four hours. The residual carbonate, on treatment with lime in the usual manner, yields two-thirds of the original amount of caustic operated upon. The sodium, after being cast, is saturated with kerosene oil, and stored in large tanks holding several tons, placed in rooms specially designed both for security against either fire or water.

CHLORINE MANUFACTURE.

This part of the works is connected with the adjacent works of Messrs. Chance Brothers by a large gutta-percha pipe, by means of which from time to time hydrochloric acid is supplied direct into the large storage cisterns, from which it is used as desired for making the chlorine. For the preparation of the chlorine gas needed in making the chloride, the usual method is employed; that is, hydrochloric acid and manganese dioxide are heated together, when chlorine gas is evolved with effervescence, and is led away by earthenware and lead pipes to large lead-lined gasometers, where it is stored.

The materials for the generation of the chlorine are brought together in large tanks, or stills, built up out of great sandstone slabs, having rubber joints, and the heating is effected by the injection of steam. The evolution of gas, at first rapid, becomes gradually slower, and at last stops; the hydrochloric acid and manganese dioxide being converted into chlorine and manganous chloride. This last compound remains dissolved in the "spent still liquor" and is reconverted into manganese dioxide, to be used over again, by Weldon's manganese recovery process. Owing to the difficulty of keeping up a regular supply of chlorine under a constant pressure directly from the stills, in order that the quantity passed into the sixty different

retorts in which the double chloride is made can be regulated and fed as desired, four large gasometers were erected. Each of these is capable of holding 1,000 cubic feet of gas, and is completely lined with lead, as are all the connecting mains, etc., this being the only available metal which withstands the corrosive action of chlorine. The gasometers are filled in turn from the stills, the chlorine consumed being taken direct from the gasometer under a regular pressure until it is exhausted, the valves being changed, the supply is taken from another holder, the emptied one being refilled from the still.

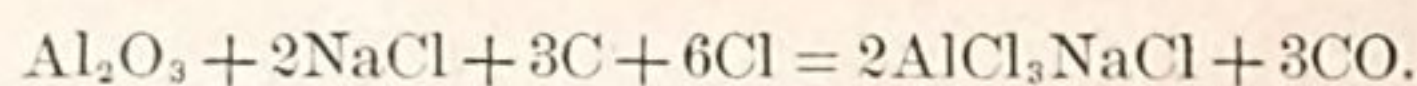
MANUFACTURE OF THE DOUBLE CHLORIDE.

Twelve large regenerative gas furnaces are used for heating, and in each of these are fixed five horizontal fire-clay retorts about 10 feet in length, into which the mixture for making the double chloride is placed. These furnaces have been built in two rows, six on a side, the clear passage way down the center of the building, which is about 250 feet long, being 50 feet in width. Above this central passage is the staging, carrying the large lead mains for the supply of the chlorine coming from the gasometers. Opposite each retort and attached to the main, are situated the regulating valves, connected with lead and earthenware pipes, for the regulation and passage of the chlorine to each retort. The valves are of peculiar design, and have been so constructed that the chlorine is made to pass through a certain depth of liquid, which not only by opposing a certain pressure allows a known quantity of gas to pass in a given time, but also prevents any return from the retort into the main, should an increase of pressure be suddenly developed in the retorts.

The mixture with which the retorts are charged is made by grinding together hydrate of alumina, salt, and charcoal. This mixture is then moistened with water, which partially dissolves the salt, and thrown into a pug mill of the usual type for making drain pipes, excepting that the mass is forced out into solid cylindrical lengths upon a platform alongside of which a workman is stationed with a large knife, by means of which the material is cut into lengths of about 3 inches each. These are then piled on top of the large furnaces to dry. In a few hours they have sufficiently hardened to allow of their being handled. They are then transferred to large wagons, and are ready to be used in charging the retorts.

The success of this process is in a great measure dependent, first, on the proportionate mixture of materials; second, on the temperature of the furnace; third, on the quantity of chlorine introduced in a given time; and fourth, on the actual construction of the retorts. I am, however, not at liberty to discuss the details of this part of the process, which have only a commercial interest. In carrying on the operation, the furnaces or retorts, when at the proper temperature, are charged by throwing in the balls until they are quite full, the fronts are then sealed up, and the charge allowed to remain undisturbed for about four hours, during which time the water of the alumina hydrate is completely expelled. At the end of this time the valves on the chlorine main are opened, and the gas is allowed to pass into the charged retorts. In the rear of each retort, and connected therewith by means of an earthenware pipe, are the condenser boxes, which are built in brick. These boxes are provided with openings or doors, and also with earthenware pipes, connected with a small flue for carrying off the uncondensed vapors to the large chimney. At first the chlorine passed into each retort is all absorbed by the charge, and only carbonic oxide escapes into the open boxes, where it burns. After a certain time, however, dense fumes are evolved, and the boxes are then closed, while the connecting pipe between the box and the small flue serves to carry off the uncondensed vapors to the chimney.

The reaction which takes place is as follows:



The chlorine is passed in for about 72 hours in varying quantity, the boxes at the back being opened from time to time by the workmen to ascertain the progress of the distillation. At the end of the time mentioned the chlorine valves are closed and the boxes at the back of the furnace are all thrown open. The crude double chloride, as distilled from the retorts, condenses in the connecting pipe and trickles down into the boxes, where it solidifies in large irregular masses. The yield from a bench of five retorts will average from 1,600 to 1,800 pounds, which is not far from the theoretical quantity. After the removal of the crude chloride from the condenser boxes the retorts are opened at their charging end, and the residue, which consists of a small quantity of alumina, charcoal, and salt is raked out and remixed in certain proportions with fresh material to be used over again. The furnace is immediately recharged and the same operations repeated, so that from each furnace upward of 3,550 pounds of chloride are obtained weekly. With ten of the twelve furnaces always at work the plant is easily capable of producing 30,000 pounds of chloride per week, or 1,500,000 pounds per annum.

Owing to the presence of iron, both in the materials used (*viz*, charcoal, alumina, etc.) and in the fire clay composing the retorts, the distilled chloride always contains a varying proportion of this metal in the form of ferrous and ferric chlorides. When it is remembered that it requires 10 pounds of this chloride to produce 1 pound of aluminium by reduction, it will be quite apparent how materially a very small percentage of iron in the chloride will influence the quality of the resulting metal. I may say that, exercising the utmost care as to the purity of the alumina and the charcoal used, and after having the retorts made of special fire clay containing only a very small percentage of iron, it was found almost impossible to produce upon a large scale a chloride containing less than 0.3 per cent. of iron.

This crude double chloride, as it is now called at the works, is highly deliquescent, and varies in color from a light yellow to a dark red. The variation in color is not so much due to the varying percentage of iron contained as to the relative proportion of ferric or ferrous chlorides present, and although a sample may be either very dark or quite light, it may still contain only a small percentage of iron if it be present as ferric salt, or a very large percentage if it is in the ferrous condition. Even when exercising all possible precautions, the average analysis of the crude double chloride shows about 0.4 per cent. of iron. The metal subsequently made from this chloride therefore never contained much less than about 5 per cent. of iron, and, as this quantity greatly injures the capacity of aluminium for drawing into wire, rolling, etc., the metal thus obtained required to be refined. This was successfully accomplished by Mr. Castner and his able assistant Mr. Cullen, and for some time all the metal made was refined, the iron being lowered to about 2 per cent.

The process, however, was difficult to carry out, and required careful manipulation, but as it then seemed the only remedy for effectively removing the iron, it was adopted and carried on for some time quite successfully, until another invention of Mr. Castner rendered it totally unnecessary. This consisted in purifying the double chloride before reduction. I can not now explain this process, but I am able to show some of the product.* This purified chloride, or pure double chloride, is, as you see, quite white, and is far less deliquescent than the crude, so that it is quite reasonable to infer that this most undesirable property is greatly due to the former presence of iron chlorides. I have seen large quantities containing upward of $1\frac{1}{2}$

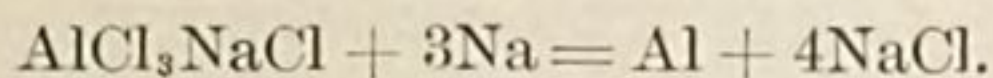
* By the reduction of the iron salts to metallic iron by melting the chloride (single or double) with a quantity of aluminium or sodium sufficient for this purpose.—United States patent.

per cent. of iron, or 150 pounds to 10,000 of the chloride, completely purified from iron in a few minutes, so that, whilst the substance before treatment was wholly unfit for the preparation of aluminium, owing to the presence of iron, the result was, like the sample exhibited, a mass containing only 1 pound of iron in 10,000, or 0.01 per cent. The process is extremely simple, and adds little or no appreciable cost to the final product. After treatment, this pure chloride is melted in large iron pots and run into drums similar to those used for storing caustic soda. As far as I am aware, it was generally believed to be an impossibility to remove the iron from anhydrous double chloride of aluminium and sodium, and few if any chemists have ever seen a pure white double chloride.

ALUMINIUM MANUFACTURE.

I now come to the final stage of the process, viz, the reduction of the pure double chloride by sodium. This is effected, not in a tube of Bohemian glass, as shown in Mr. Barlow's lecture in 1856, but in a large reverberatory furnace, having an inclined hearth about 6 feet square, the inclination being toward the front of the furnace, through which are several openings at different heights. The pure chloride is ground together with cryolite in about the proportions of two to one, and is then carried to a staging erected above the reducing furnace. The sodium, in large slabs or blocks, is run through a machine similar to an ordinary tobacco-cutting machine, where it is cut into small thin slices; it is then also transferred to the staging above the reducing furnace.

Both materials are now thrown into a large revolving drum, when they become thoroughly mixed. The drum being opened and partially turned, the contents drop out into a car on a tramway directly below. The furnace having been raised to the desired temperature, the dampers of the furnace are all closed to prevent the access of air, the heating gas being also shut off. The car is then moved out on the roof of the furnace until it stands directly over the center of the hearth. The furnace roof is provided with large hoppers, and through these openings the charge is introduced as quickly as possible. The reaction takes place almost immediately, and the whole charge quickly liquefies. At the end of a certain time the heating gas is again introduced and the charge kept at a moderate temperature for about two hours. At the end of this period the furnace is tapped by driving a bar through the lower opening, which has previously been stopped with a fire-clay plug, and the liquid metal run out in a silver stream into molds placed below the opening. When the metal has all been drawn off, the slag is allowed to run out into small iron wagons and removed. The openings being again plugged up, the furnace is ready for another charge. From each charge, composed of about 1,200 pounds of pure chloride, 600 pounds of cryolite, and 350 pounds of sodium, about 115 to 120 pounds of aluminium are obtained.



The purity of the metal entirely depends upon the purity of the chloride used, and without exercising more than ordinary care the metal tests usually indicate a purity of metal above 99 per cent. On the table is the metal run from a single charge, its weight is 116 pounds, and its composition, as shown by analysis, is 99.2 aluminium, 0.3 silicon, and 0.5 iron. This I believe to be the largest and the purest mass of metal ever made in one operation.

The result of eight or nine charges are laid on one side, and then melted down in the furnace to make a uniform quality, the liquid metal, after a good stirring, being drawn off into molds. These large ingots, weighing about 60 pounds each, are sent to the casting shop, there to be melted and cast into the ordinary pigs or other shapes, as may be required for the making of tubes, sheets, or wire, or else used directly for making alloys of either copper or iron.

The following table shows approximately the quantity of each material used in the production of 1 ton of aluminium :

Metallic sodium.....	pounds..	6,300
Double chloride	do....	22,400
Cryolite.....	do....	8,000
Coal.....	tons..	8

To produce 6,300 pounds of sodium is required :

Caustic soda.....	pounds..	44,000
Carbide made from pitch, 12,000 pounds, and iron turnings, 1,000 pounds	pounds..	7,000
Crucible castings.....	tons..	2½
Coal	do ...	75

For the production of 22,400 pounds double chloride is required ;

Common salt	pounds..	8,000
Alumina hydrate.....	do....	11,000
Chlorine gas	do....	15,000
Coal	tons..	180

For the production of 15,000 pounds of chlorine gas is required:

Hydrochloric acid	pounds..	180,000
Limestone dust	do....	45,000
Lime	do....	30,000
Loss of manganese	do....	1,000

It might seem, on looking over the above numbers, as if an extraordinary amount of waste occurred, and as if the production is far below that which ought to be obtained, but a study of the figures will show that this is not the case.* I would wish to call attention to one item in particular, viz, fuel, it having been remarked that the consumption of coal must prevent cheap production. I think when it is remembered that coal, such as used at the works, cost only 4s. per ton, while the product is worth £2,240 per ton, the cost of coal is not an item of consequence in the cost of production. The total cost of the coal to produce 1 ton of metal being £50, the actual cost for fuel is less than 6*d.* for every pound of aluminium produced. The ratio of cost of fuel to value of product is indeed less than is the case in making either iron or steel. In concluding my remarks as to the method of manufacture and the process in general, I may add that I do not think it is too much to expect, in view of the rapid strides already made, that in the future, further improvements and modifications will enable aluminium to be produced and sold even at a lower price, than appears at present possible.

PROPERTIES OF ALUMINIUM.

In its physical properties aluminium widely differs from all the other metals. Its color is a beautiful white with a slight blue tint. The intensity of this color becomes more apparent when the metal has been worked, or when it contains silicon or iron. The surface may be made to take a very high polish, when the blue tint of the metal become manifest, or it may be treated with caustic soda and then nitric acid, which will leave the metal quite white. The extensibility or malleability of aluminium is very high, ranking with gold and silver if the metal be of good quality. It may be beaten out into thin leaf quite as easily as either gold or silver, although it requires more careful annealing.

*These works can produce 500 pounds of aluminium per day. The metal run out represents 70 per cent. of the aluminium in the charge and 80 per cent. of the weight which the sodium put in should reduce.—Richards.

It is extremely ductile and may be easily drawn, especial care only being required in the annealing.

The sonorousness of aluminium is very great. Faraday has remarked, after experiments conducted in his laboratory, that the sound produced by an ingot of aluminium is not simple, and one may distinguish two sounds by turning the vibrating ingot.

After being cast it has about the hardness of pure silver, but may be sensibly hardened by hammering.

Its tensile strength varies between 12 and 14 tons to the inch (test sample which was shown having been broken at 13 tons or 27,000 pounds), ordinary cast-iron being about 8 tons. Comparing the strength of aluminium in relation to its weight, it is equal to steel of 38 tons tensile strength. The specific gravity of cast aluminium is 2.58, but after rolling or hammering this figure is increased to about 2.68.

The specific gravity of aluminium being 1, copper is 3.6, nickel 3.5, silver 4, lead 4.8, gold 7.7.

The fusibility of aluminium has been variously stated as being between that of zinc and silver, or between 600° and $1,000^{\circ}$ C.

As no reliable information has ever been made public on this subject, my friend, Professor Carnelley, undertook to determine it. I was aware, from information gained at the works at Oldbury, that a small increase in the percentage of contained iron materially raised its point of fusion, and it has been undoubtedly due to this cause that such wide limits are given for the melting point. Under these circumstances two samples were forwarded for testing, of which No. 1 containing 0.5 per cent. of iron, had a melting point of 700° C.; whereas No. 2, containing 5 per cent. of iron, does not melt at 700° and only softens somewhat above that temperature but undergoes incipient fusion at 730° .

According to Faraday, aluminium ranks very high among metallic conductors of heat and electricity, and he found that it conducted heat better than either silver or copper. The specific heat is also very high, which accounts for length of time required for an ingot of the metal to either melt or get cold after being cast.

Chemically, its properties are well worthy of study.

Air, either wet or dry, has absolutely no effect on aluminium at the ordinary temperature, but this property is only possessed by a very pure quality of metal, and the pure metal in mass undergoes only slight oxidation even at the melting point of platinum.

Thin leaf, however, when heated in a current of oxygen, burns with a brilliant bluish white light. If the metal be pure, water has no effect on it whatever, even at a red heat. Sulphur and its compounds also are without action on it, while, under the same circumstances, nearly all metals would be discolored with great rapidity.

Dilute sulphuric acid and nitric acid, both diluted and concentrated, have no effect on it, although it may be dissolved in either hydrochloric acid or caustic alkali. Heated in an atmosphere of chlorine it burns with a vivid light, producing aluminium chloride. In connection with the subject it may be of interest to state the true melting point of the double chloride of aluminium and sodium, which has always been given at 170° to 180° C., but which Mr. Baker, the chemist to the works, finds lies between 125° and 130° C.

USES OF ALUMINIUM.

Its uses, unalloyed, have heretofore been greatly restricted. This is, I believe, alone owing to its former high price, for no metal possessing the properties of aluminium could help coming into larger use if its cost were moderate. Much has been said as to the impossibility of soldering it being against its popular use, but I believe that this difficulty will soon be overcome. The following are a few of the purposes

to which it is at present put: telescope tubes, marine glasses, eyeglasses and sextants, especially on account of its lightness. Fine wire for the making of lace, embroidery, etc. Leaf in the place of silver leaf, sabre sheaths, sword handles, etc., statuettes and works of art, jewelry and delicate physical apparatus, culinary utensils, harness fittings, metallic parts of soldiers' uniforms, dental purposes surgical instruments, reflectors (it not being tarnished by the products of combustion), photographic apparatus, aëronautical and engineering purposes, and especially for the making of alloys.

ALLOYS OF ALUMINIUM.

The most important alloys of aluminium are those made with copper. These alloys were first prepared by Dr. Percy, in England, and now give promise of being largely used. The alloy produced by the addition of 10 per cent. of aluminium to copper, the maximum amount that can be used to produce a satisfactory alloy, is known as aluminium bronze. Bronzes, however, are made which contain smaller amounts of aluminium, possessing in a degree the valuable properties of the 10 per cent. bronze. According to the percentage of aluminium up to 10 per cent., the color varies from red gold to pale yellow. The 10 per cent. alloy takes a fine polish, and has the color of jewelers' gold. The 5 per cent. alloy is not quite so hard, the color being very similar to that of pure gold. I am indebted to Prof. Roberts Austen for a splendid specimen of crystallized gold, as also for a mold in which the gold at the mint is usually cast, and in this I have had prepared ingots of the 10 and 5 per cent. alloy, so that a comparison may be made of the color of these with a gold ingot cast in the same mold, for the loan of which I have to thank Messrs. Johnson, Matthey & Co., all of which are before you.

I have also ingots of the same size, of pure aluminium, from which an idea of the relative weights of gold and aluminium may be obtained.

To arrive at perfection in the making of these alloys, not only is it required that the aluminium used should be of good quality, but also that the copper must be of the very best obtainable. For this purpose only the best brands of Lake Superior copper should be used. Inferior brands of copper or any impurities in the alloy give poor results. The alloys all possess a good color, polish well, keep their color far better than all other copper alloys, are extremely malleable and ductile, can be worked either hot or cold, easily engraved, the higher grades have an elasticity exceeding steel, are easily cast into complicated objects, do not lose in remelting, and are possessed of great strength, dependent, of course, on the purity and percentage of contained aluminium. The 10 per cent. alloy, when cast, has a tensile strength of between 70,000 and 80,000 pounds per square inch, but when hammered or worked, the test exceeds 100,000 pounds. (A sample shown broke at 105,000 pounds.)

An attempt to enumerate either the present uses or the possible future commercial value of these alloys is beyond my present purpose. I may, however, remark that they are not only adapted to take the place of bronze, brass, and steel, but they so far surpass all of those metals, both physically and chemically, as to make their extended use assured. (Sheets, rods, tubes, wire, and ingots shown.)

But even a more important use of aluminium seems to be its employment in the iron industry, of which it promises shortly to become a valuable factor, owing to certain effects which it produces when present, even in the most minute proportions. Experiments are now being carried on at numerous iron and steel works, in England, on the continent, and in America. The results so far obtained are greatly at variance, for whilst in the majority of cases the improvements made have encouraged the continuance of the trials, in others the result has not been satisfactory. On this point I would wish to say to those who may contemplate making use of aluminium in this direction, that it would be advisable before trying their experiments to ascer-

tain whether the aluminium alloy they may purchase actually contains any aluminium at all, for some of the so-called aluminium alloys contain little or no aluminium, and this may doubtless account for the negative results obtained. Again, others contain such varying proportions of carbon, silicon, and other impurities as to render their use highly objectionable.

It seems to be a prevailing idea with some people, that because aluminium is so light compared with iron, that they can not be directly alloyed, and furthermore, that for the same reason, alloys made by the direct melting together of the two metals would not be equal to an alloy where both metals are reduced together. Now, of course, this is not the case, and the statement has been put forward by those who were only able to make the alloys in one way.

Aluminium added to molten iron and steel lowers their melting points, consequently increases the fluidity of the metal, and causes it to run easily into molds and set there, without entrapping air and other gases, which serve to form blow holes and similar imperfections. It is already used by a large number of steel founders, and seems to render the production of sound steel castings more certain and easy than is otherwise possible.

One of the most remarkable applications of this property which aluminium possesses of lowering the melting-point of iron has been made use of by Mr. Nordenfelt in the production of castings of wrought iron.

Aluminium forms alloys with most other metals, and although each possess peculiar properties which in the future may be utilized, at present they are but little used.

In conclusion, I beg to call your attention to the wood models on the table, one being representative of aluminium, the other aluminium bronze. The originals of these models are now in the Paris Exhibition, each weighing 1,000 pounds. With regard to aluminium bronze, I can not speak positively, but the block of pure aluminium is undoubtedly the largest casting ever made in this most wonderful metal. I have to thank the directors of the Aluminium Company, and especially Mr. Castner, for furnishing me with the interesting series of specimens of raw and manufactured metal for illustrating my discourse.

NOTE.—The exhibit consisted of 5 to 6 cwt. of aluminium (98 to 99 per cent.) in various sizes of pigs, ingots, sheet, wire, foil, tubes, and rods; two large blocks, together weighing 116 pounds, and testing 99.2 per cent. aluminium, as run direct from the furnace in one charge; 4 cwt. of aluminium bronzes in pigs, ingots, wire, tubes, sheet, and rods; aluminium iron and steel, 10 and 20 per cent. aluminium, 1 cwt. of each in pigs; sodium in cast bars; double chloride of aluminium and sodium (crude and purified).

The following is extracted from a pamphlet published by this company:

PROPERTIES.

The properties here mentioned only relate to the metal (as manufactured by this company) containing 97 to 98 per cent. of aluminium, which possesses a luster closely approaching silver, and has a specific gravity of about one-third of that of iron. It is almost as malleable as silver, with which metal it compares favorably in regard to ductility, elasticity, tenacity and hardness. Its melting point is between that of silver and copper, and while it conducts heat better than the former, it ranks next to the latter as a conductor of electricity. It is not acted upon by sulphurous gases, nor by air at ordinary temperatures, which would, under like circumstances, greatly discolor silver; and while it dissolves freely in hydrochloric acid and strong caustic alkalis, it withstands the action of nitric, sulphuric and organic acids to a considerable degree.

MANIPULATIONS IN WORKING.

Melting is best performed in an ordinary plumbago crucible, although an earthen crucible will answer.

No flux should be used, and only part of a charge must be melted at a time, adding little by little, and so increasing the charge as the mass becomes melted. The pieces which are to be melted should be dipped in benzine previous to being put in the crucible. As the melted aluminium reduces the silica of the crucible to silicon, forming an alloy, and therefore becoming impure, the fewer times the metal is melted the less liable it is to become contaminated.

Casting can easily be accomplished either in metallic molds, or, preferably, in sand for complicated objects. Care should be taken that the mold be dry, and so constructed as to freely allow the escape of air replaced by viscous metal. The mold should be provided with many vents, and should also have a perfectly round git. The melted metal must be quickly poured, allowing enough, however, to remain in the git to provide for the contraction upon solidification. Covered iron ingot molds serve best for casting bars which are intended to be rolled.

Rolling and drawing is accomplished as with other metals, but owing to its quickly losing its temper it requires to be more frequently annealed. The proper temper for annealing is a very low red heat. When drawing into wire, the diameter should be very gradually reduced with frequent heating, special care being taken regarding the temperature, owing to the fusibility of the metal.

Soldering is not easily accomplished, although the company hopes very shortly to place before their customers a perfect method, in the mean time special information will be supplied to those desiring it.

Burnishing.—The polishing stone is dipped into an emulsion made of equal parts of rum and olive oil, and the metal polished like silver, special care being taken not to press too hard in shining up. Hammered and pressed objects of aluminium before being polished, can be easily ground by using olive oil and pumice.

Matting, silvering, gilding, etc.—Aluminium takes a beautiful mat, which is quite easily obtained by plunging the object into a very dilute solution of caustic soda for an instant, washing well in water, and then dipping into strong nitric acid. The surface thus given will keep indefinitely in the air. Silvering, gilding, etc., of aluminium require special information, depending upon the results desired, which will be furnished on application to the company.

USES OF ALUMINIUM.

Heretofore the two points which have stood in the way of the extensive use of aluminium, in the many directions for which its varied valuable properties have fitted it, have been: First, its excessive cost; second, its impurity. That this company has overcome these obstacles is proved by its now offering for sale in any desired quantity, a metal guaranteed to contain above 97 per cent. of aluminium, at the price of 20s. per pound. In comparing the price of aluminium with metals such as nickel, tin, or silver, it must be borne in mind that, for the same bulk, it is only about one-quarter the weight; so that, while an object made in aluminium weighing one pound would cost 20s., a similar object made in either nickel, tin, or silver would weigh 4 pounds, and cost 9s., 7s., and 180s., respectively. Thus, for the same bulk, it is only two and a quarter times the cost of nickel, three times the cost of tin, and one-ninth the cost of silver. The principal use of aluminium at present is in the production of alloys, and for this purpose it is most eminently adapted; small percentages increase the strength of and render far more unoxidizable the metals and alloys to which it is added. The following are but a few of the numberless uses to which it has been put at various times, and now that the different trades are assured of a constant supply at a reasonable price, nothing can

prevent its rapidly entering into everyday uses: Telescope tubes, opera glasses, sextants, physical and surgical apparatus, statuettes and works of art, culinary utensils, coinage, leaf in place of gold and silver, jewelry, ballooning purposes, and in place of any metal now used where lightness and resistance to oxidation are advantages.

ALUMINIUM SILVER, IN PIGS, INGOTS, SHEETS, RODS, AND WIRE.

Aluminium	93½ to 95
Silver.....	4¾ to 5

Properties.—This alloy possesses in a degree the properties of pure aluminium, excepting that it is much harder, takes a fine polish, does not oxidize under ordinary conditions, and has nearly the color of pure silver.

Manipulation in working.—The same directions given with reference to pure aluminium apply to this alloy.

Uses.—For any purpose in place of silver, or in place of pure aluminium where a harder metal is required, combining lightness with the hardness.

ALUMINIUM BRONZES, IN PIGS, INGOTS, SHEETS, RODS, AND WIRE.

[Analysis guarantied.]

Grade.	Copper.		Aluminium.	
	Per cent.		Per cent.	
A	89	to 90	9½	to 10
B	92½	98	7	7½
C.....	94½	95	4½	5
D	97	97½	2	2½

SCIENTIFIC EXTRACTS REGARDING THE PROPERTIES, MANIPULATIONS, AND USES OF THESE BRONZES.

From Deville.—“The aluminium and copper alloys with 2 or 3 per cent. of aluminium are used by Mr. Christofle for large castings of objects of art. They are harder than aluminium, and work well under the burin and chisel.”

“The alloy with 10 per cent. of aluminium had its useful properties first described by Mr. Debray. It is very hard, can be beaten when cold, but with remarkable perfection when hot, and may well be compared to iron, which it resembles in all these physical properties; it is also very ductile.

“The 10 per cent. aluminium alloy is usually known as aluminium bronze. It behaves as a true alloy, and in consequence will not liquate into different combinations. This is proven by the fact that, when in making the alloy, the *pure copper* is in the crucible, and a bar of aluminium is added, the combination takes place with such disengagement of heat, that if the crucible is not of good quality it will be fused, for the whole attains a white heat. The color of the bronze is exactly that of ‘green gold’ (an alloy of gold and silver), and it receives a beautiful polish, being comparable in this regard only to steel. Its chemical properties do not differ much from those of most of the alloys of copper. However, in numerous experiments, it has been found to resist most chemical agents much better than these, especially sea water and sulphureted hydrogen. Its tenacity is equal to steel. According to experiments as to its wear in the form of journal boxes, it is found to wear away less than any other journal metal yet tried. Its malleability is almost perfect, as is seen by the following report of Mr. Boudaret, a practical engineer: ‘First, aluminium bronze is malleable at all temperatures, from bright red to cold; sec-

ond, it is perfectly malleable at a red heat, breaking less and elongating more than pure copper; third, it is hard to roll in the cold, after several passes it ceases to elongate, and must then be annealed very often, or it will break quickly; fourth, it results from the foregoing that it is best to roll it at as great a heat as possible below fusion; annealing and tempering render it softer than simple annealing. If after being annealed at a bright red heat it is let cool in still air to redness and then plunged in cold water it is ductile and malleable enough in the cold to stand all industrial working.' "

From Tessier Brothers.—"Just as copper increases the hardness of aluminium, so aluminium in small proportions increases the hardness of copper; however, aluminium does not injure its malleability, but makes it susceptible of taking a beautiful polish, and, according to the proportions, varies its color from red gold to pale yellow.

"These facts were announced some time back by Dr. Percy, in England. We have made large quantities of these alloys, and we may say that they leave nothing to be desired in luster or color to make them perfect imitations of gold. They alter much less by successive fusions than the alloys of copper with tin and zinc, employed for the same purpose. A 10 per cent. aluminium alloy was harder than our gold coin, took a fine polish by burnishing, and had the color of pale jewelers' gold; it could be forged and worked the same as copper. The 5 per cent aluminium alloy was less hard than the preceding, but, like it, takes a fine polish, and in tint approaches nearly to pure gold. Alloys with 5 per cent. to 10 per cent. of aluminium may have their color changed at will, either by leaving in nitric acid, which takes away the copper and leaves the aluminium, or in hydrochloric, which takes away the aluminium, leaving the copper. The resistance, hardness, and elasticity which are communicated to copper by introducing small quantities of aluminium will certainly make these important industrial alloys."

From Mierzinski.—"Two points are to be attended to in making aluminium bronze. First: *A pure copper must be used.* The best is that electrically deposited, but it generally costs too much. The next best is the Lake Superior brand; the usual commercial copper gives all sorts of poor results, owing to the antimony, arsenic, tin, zinc, or iron contaminating it. The bronze loses by being alloyed with zinc or tin. Secondly, the alloy must be remelted two or three times to remove its brittleness.

"In all probability the percentage of aluminium increases by remelting. The usual alloys are those of 1, 2, 5, and 10 per cent. aluminium. The 5 per cent. bronze is golden in color, polishes well, and casts beautifully; is very malleable cold or hot, and has great strength, especially after hammering. The $7\frac{1}{2}$ per cent. bronze is to be recommended as superior to the 5 per cent.; it has a peculiar greenish gold color, which makes it very suitable for decoration.

"All these good qualities are possessed by the 10 per cent. bronze. It is bright golden, keeps its polish in the air, may be easily engraved, shows an elasticity much greater than steel, and can be soldered with hard solder. It gives good castings of all sizes, and runs in sand molds very uniformly. Thin castings come out very sharp, but if a casting is thin and suddenly thickens, small offshoots must be made at the thick place into which the metal can run, and then soak back into the castings by shrinkage at the thick part. Its strength, when cast, is between that of iron and steel, but when hammered, is equal to the best steel. It may be forged at about the same heat as cast steel, and then hammered until it is almost cold without breaking or ripping. Tempering makes it soft and malleable. It does not foul a file, and may be easily drawn into wire. Any part of a machine which is usually made of steel can be replaced by this bronze.

"As a solder for it, Hulot uses an alloy of the usual half-and-half lead-tin solder with $12\frac{1}{2}$, 25 or 50 per cent. of zinc 'amalgam.' "

From Roscoe & Schorlemmer's Chemistry.—"Copper forms an alloy with aluminium, possessing the color of gold. For the preparation of this alloy *chemically pure copper must be employed*, as that which contains iron yields an inferior product. When fused several times it becomes malleable, yet yields fine castings, takes a fine polish, and is equal to steel in tensile strength. As in the case of aluminium, great hopes were entertained of the employment of this alloy, as it is less alterable in air than even brass or bronze. Rifle barrels, and even rifle cannon have been made from it. These appear to answer admirably, but the high price of 6s. per pound has prevented its general employment."

From Thurston's Materials for Engineering.—"The 10 per cent. bronze has a tenacity of about 100,000 pounds, compressive strength 130,000 pounds, and its ductility and toughness are such that it does not even crack when distorted by this load. It is so ductile and malleable that it can be drawn down under a hammer to the fineness of a cambric needle. It works well, casts well, holds a fine surface under the tool, and, when exposed to the weather, it is in every respect the best bronze known. Its high cost has alone prevented its extensive use in the arts. The alloys are very uniform in character. Every 1 per cent. of aluminium added to copper causes a considerable increase in ductility, increases its fusibility, and enables it to cast well; 2 per cent. gives a mixture used for castings which are to be worked with a chisel. It is softened by sudden cooling from a red heat. Its coefficient of expansion is small at ordinary temperatures. It has great elasticity when made into springs."

The users of aluminium bronze will find that the above described valuable properties are only possessed by bronzes which are practically free from iron, silicon, or carbon.

SUGGESTIONS TO BE OBSERVED IN CASTING ALUMINIUM BRONZE.

Melting point of aluminium bronze is about the same as gun metal; if anything, a little higher, the low per cent. alloy requiring the higher temperature.

Shrinkage is about 50 per cent. more than brass, and due allowance must be made for this in molding. Cores to be made on hay-bands, if large, and as yielding as can be at all times, and mold must be cut away on metal setting, to prevent breaking of casting, if the shape requires it.

Green sand cores may be used in some cases for small castings, or rosin in coarse sand, and plenty of cinders to make it yielding.

Risers and feeding heads must be larger than casting where fed, and not too short, so as to have plenty of metal fluid up to time of setting in the real casting. It can not well be pumped or fed with a rod, as in iron casting.

All gates, etc., to be as large as possible, as the metal should be poured quickly, and as cold as it will run, to avoid the excessive shrinkage.

Dry sand molds to be of a good open character, green sand for small castings may be finer.

Good venting in all cases.

The metal should be kept covered with charcoal, to guard against formation of oxide as much as possible, and in large castings, poured from a hole in bottom of ladle, opened or closed with a plug, as in steel casting. Smaller castings may have a basin to hold all the metal necessary, on top of mold and shut with a plug of iron; fill this from ladle, and when scum is risen draw the plug. Or a combination of these methods may be used, according to circumstances, the main object being to keep out the oxide by running from the bottom of metal.

If metal is run to bottom of mold first, and run cool, it might be found advisable to put some warmer metal on top of risers when they show, so they may remain fluid a little longer. The same ladle will suffice perhaps, as metal has not traversed the mold.

Iron molds, for wire strips, etc., black with mixture of plumbago, pipe clay, and lard oil, and pour quickly.

FERRO-ALUMINIUM (ALUMINIUM STEEL) IN PIGS AND INGOTS.

A grade (guaranteed analysis):

	Per cent.
Aluminium	19½ to 20
Iron	79½ to 80

B grade (guaranteed analysis):

	Per cent.
Aluminium	9½ to 10
Iron	89½ to 90

The following analyses from Joseph W. Richards' book on "Aluminium," Philadelphia, 1890, will show the amount of impurities present in commercial aluminium, and also, incidentally, the improvement which has been achieved since the beginning of the industry in 1854:

No.	Process.	Aluminium.	Silicon.	Iron.
1	Dewille	88.350	2.87	2.40
2	...do	92.500	0.70	6.80
3	...do	92.000	0.45	7.55
4	...do	92.969	2.149	4.88
5	...do	94.700	3.70	1.60
6	...do	96.160	0.47	3.37
7	Tissier Brothers.....	94.800	4.40	0.80
8	Morin & Co., Nanterre	97.200	0.25	2.40
9	...do	97.000	2.70	0.30
10	...do	98.290	0.04	1.67
11	...do	97.680	0.12	2.20
12	Merle & Co., Salindres.....	96.253	0.454	3.293
13	...do	96.890	1.270	1.840
14	...do	97.400	1.00	1.30
15	...do	97.600	0.40	1.40
16	Frishmuth	97.490	1.90	0.61
17	...do	97.750	1.70	0.55
18	Hall	98.340	1.34	0.32
19	Dewille-Castner	99.200	0.50	0.30
20	Grabau	99.620	0.23	0.15
21	...do	99.800	0.12	0.08

Notes on the above analyses—

1. Analyzed by Salvétat. Contained also 6.38 per cent. of copper and a trace of lead.
- 2 and 6. Analyzed by Dumas.
3. Parisian aluminium bought in La Haag.
4. Analyzed by Salvétat. Contained also a trace of sodium.
5. Parisian aluminium bought in Bonn and analyzed by Dr. Kraut.
7. Made at the works near Rouen, in 1858, from cryolite. Analyzed by Démon-deur.
8. Analyzed by Sauerwein. Contained also traces of lead and sodium.
9. Analyzed by Morin. Average of several months' work.
- 10, 11. Analyzed by Kraut. Represents the best product of the French works sent to the London Exhibition in 1862.

- 12, 13. Analyzed by Mallet. The best metal which could be bought in 1880. Purchased in Berlin by Mallet and used by him as the material which he purified and used for determining the atomic weight of aluminium.
- 14, 15. Analyzed by Hampe. This was the purest metal which could be bought in 1876. No. 14 contained also 0.10 per cent. of copper and 0.20 per cent. of lead. No. 15 contained 0.40 per cent. of copper and 0.20 per cent. of lead.
16. Bought in Philadelphia as Frishmuth's aluminium, in 1885, and analyzed by the author.
17. Specimen of the metal composing the tip of the Washington Monument, cast by Frishmuth. This analysis is reported by R. L. Packard in the Mineral Resources of the United States, 1883-'84.
18. The best grade of metal made by this process, analyzed by Hunt & Clapp, Pittsburgh :
19. The best grade made by this process, exhibited at the Paris Exposition, 1889. Analyzed by Cullen.
20. Analysis by Dr. Kraut of metal being made on a commercial scale.
21. Analysis by Grabau of the purest metal yet obtained by his process.

According to Rammelsberg (Kerl's Handbuch) the silicon which is always found in aluminium is in part combined with it, and this combined silicon changes by treatment with hydrochloric acid into either silica, which remains, or into silicon hydride, SiH_4 , which escapes; while another part of it is combined with the aluminium just as graphite is with iron; and this part remains on treatment with acid as a black mass not oxidized by ignition in the air. Two analyses of aluminium reduced from cryolite by sodium in a porcelain crucible gave—

	1.	2.
Silicon obtained as silica.....	9.55	1.85
Free silicon	0.17	0.12
Silicon escaping in SiH_4	0.74	0.58

ALLIANCE ALUMINIUM COMPANY, LIMITED, LONDON, ENGLAND.

Founded in 1888. Capital, £500,000. Aluminium up to 99.5 per cent. of purity and aluminium alloys. Works at Wallsend-on-Tyne.

This company manufactures sodium and aluminium by the Netto patented processes. Metallic sodium is produced by percolating caustic soda through a column of hot charcoal in large cast-iron pots. The vapors of sodium rise to the surface and are condensed in suitable apparatus, while the residue, consisting chiefly of carbonate of soda, is withdrawn through a tapping hole in the lower part of the pot. Fresh supplies of charcoal and caustic soda are then introduced, so that the production goes on continuously. Each pot produces 80 to 100 pounds of sodium per day. The residue could easily be reconverted into caustic soda, but the company has found it more advantageous to sell it. The aluminium is made by a modification

of the Deville process, which is the decomposition of aluminium-sodium chloride by sodium with cryolite or fluor spar as a flux.

The Alliance Company uses the mineral cryolite (an aluminium-sodium fluoride), which they obtain under a special arrangement with the owners of the only known mine in the world, in Greenland. It has been known since 1855 that aluminium could be obtained from this mineral by reduction with sodium, in which year it was announced by H. Rose. The product, however, was low in quantity in proportion to the amount of sodium used. The Alliance Company melt the cryolite in reverberatory furnaces, probably with sodium chloride, and it is then suddenly brought into contact with the sodium, whereupon the reaction is completed in a few minutes and the aluminium is separated. Netto used a vessel swung on trunnions, in which the sodium was placed and covered by a perforated aluminium plate. The melted cryolite was poured upon the plate, which caused the sodium to rise more slowly through it and effect the reduction. The contents were then poured into settling vessels. This, or a similar method, is probably used by this company. The resulting slag, consisting of sodium-fluoride and chloride, is reconverted into aluminium-sodium fluoride by decomposition with aluminium sulphate. The sodium sulphate is removed by washing with water.

The exhibits of this company consisted of two hollow blocks of aluminium, one placed upon the other, the lower one about 3 by 4 feet and 2 feet high, the upper smaller. The columns and balustrades were made of aluminium sheet, rolled to shape. Metallic sodium in globes was also shown. This metal was offered in Paris at 20s per pound in the summer of 1889.

This company received a gold medal.

BERNARD FRÈRES, PARIS.

An exhibit of aluminium, pure and in its alloys; ingots, plate, tubes, castings, etc.

They use the electrolytic process of Adolph Minet. This process consists in the electrolysis of a melted bath, when aluminium fluoride, in the state of a single or a double salt, is used, not as a flux but as the main electrolyte, being subjected to the influence of the current. The decomposition takes place in a crucible of refractory earth, or of plumbago, or of metal, and when an alloy is required, the crucible may serve as the cathode or as the anode. The crucible is inclosed in a brick covering to avoid filtration. In making pure aluminium a derived current is used on the crucible, and an inner crucible of fused alumina or fluoride of calcium or carbon to receive the metal. The bath may consist of aluminium fluoride 40, sodium chloride, 60; or cryolite 20 to 50, sodium chloride 80 to 50; or aluminium fluoride 35, sodium fluoride 10, sodium chloride 55.

Electrodes.—For aluminium: carbon, or anode carbon cathode, copper or cast-iron.

For aluminium bronze: anode, red copper or carbon; cathode, copper or carbon.

For ferro-aluminium: anode, iron or carbon; cathode, iron or carbon.

In making pure metal the charge is melted in the iron crucible, protected by the brick covering, and the current passed through it. The cathode of carbon is placed in an inner small crucible, as mentioned before, and the outer crucible is protected from the corroding action of the bath by passing a derived current which is diminished by the interposition of a resistance coil. An alloy of aluminium and of the metal of the tank is formed which protects the latter from the action of the bath.

In making an alloy, the tank or crucible is made of the metal which forms a component part of such alloy. The anodes are of carbon and the crucible is the cathode. As fast as the aluminium is produced there is formed on the inner sides of the crucible a layer of aluminium alloy. When this alloy is sufficiently rich in aluminium, the metal formed anew runs to the bottom of the crucible; a tap-hole at the bottom is provided for the withdrawal of the alloy. For each kilogramme of aluminium, 3 kilogrammes of aluminium fluoride would be added, but half of the salt is regenerated by adding alumina. To produce 100 kilogrammes of aluminium there would be required:

	Kilogrammes.
Aluminium fluoride.....	150
Alumina	200
Sodium chloride.....	100

To produce this quantity, it is stated that 200 horse-power, for 20 hours, will be required, and twenty-five crucibles for pure aluminium or eighteen for alloys. This is equal to 25 grammes per horse-power per hour.

This firm received a gold medal.

COWLES ELECTRIC SMELTING AND ALUMINIUM COMPANY, LOCKPORT,
NEW YORK.

This company exhibited specimens of corundum and of aluminium alloys, silicon bronze, aluminium bronze, etc. It uses the Cowles patent, date of 1885. The works at Lockport were first operated in 1886, utilizing a water-power, of 1,000 H. P. producing aluminium and silicon alloys. Bauxite from France is used in the production of ferro-aluminium and corundum from Georgia for aluminium bronze and brass. The annual product is valued at \$150,000.

The works at Stoke-on-Trent, England, commenced operations in 1888, employs steam power equal to 600 horse-power, and gives a product of £20,000 annually.

This company received a gold medal.

STATEMENT BY THE COMPANY.

The basis of the Cowles process is the production of an incandescent heat never before obtained in any furnace, its intensity being sufficient to reduce the most refractory ores—the intensity and application of such heat being under perfect control and of practical use. The principal use to which the process hereinafter described has been confined so far is to the direct reduction of aluminium and silicon ores, but the experience gained makes it highly probable that it may be applied at no distant date to the reduction of all refractory ores and even the baser metals.

The primary agent is electricity, or the direct conversion of energy into heat, in a defined zone of moderate dimensions. In practice we produce aluminium from bauxite or any clay which contains a moderate percentage of alumina. To produce this heat we can employ either the direct or alternating type of dynamo, thus proving that the reduction is not dependent on electrolysis. Assuming that suitable dynamo and leads are provided, the furnace shown is constructed as follows: Consisting of an oblong receptacle, the internal dimensions being 5 feet long by 3 feet 3 inches deep, and 20 inches wide.

The furnace is lined only with one course of fire brick; into the ends are built tubes, as shown, placed at the incline toward the bottom of the furnace, the outer or farther end being carefully closed round the electrodes to exclude the air. The top of the furnace is covered by a cast-iron plate also luted to fit airtight; the top is provided with a suitable hole to permit of the escape of the gases formed by the intense heat, a suitable uptake being provided to carry them off, such uptake having a trap for the collection of any solids carried off containing any useful waste products, which are periodically collected and returned to the furnace. The electrodes within the furnace consist of carbon rods or plates of ample capacity to carry the current to the materials operated on without being themselves overheated. The charge to be acted on is placed between the electrodes, as shown, and is mixed with sufficient broken carbon, which, being a conductor of very high resistance, becomes intensely incandescent and reduces the surrounding ores. To prevent injury to the furnaces each charge is surrounded by a cheap and readily provided lining specially prepared for the purpose. The drawing shows the arrangement of leads, etc. The form of the furnace shown is of the older type in common use, which is, however, being materially modified so as to concentrate the zone of heat and equalize the resistance by which the waste of energy will be reduced. Several runs have been made by which a pound of aluminium has been produced with an expenditure of 17 estimated horse-power per hour, from this will be seen the low cost of production. Up to the present time, we have produced a rich alloy only in the furnace, in cop-

per alloys up to 42 per cent., in ferro, say, to 27 per cent. Thus, in charging the furnace, we add the desired quantity of copper or iron to the bauxite, corundum, or other clay used, the rich alloy produced being graded and standardized by the addition of copper or iron.

The following is extracted from a pamphlet issued by the Cowles Company:

ALUMINIUM BRONZE.

Composed of aluminium and copper; has great tensile strength, high resistance to compression, low specific gravity, and greater resistance to oxidation, corrosion, or sulphurizing action than any alloy known. Forges hot or cold, and can be remelted several times without detriment to its qualities. Its elastic limit is higher than that of mild steel. It can be graded either as to extreme hardness or great ductility, as may be required.

Average strength, etc., in castings.

Grade.	Tensile strength per square inch.	Elongation.
	Tons.	Per cent.
A (11 per cent.) (special hard)	45 to 50	Nil to 5
A 1. (10 per cent.).....	46 to 45	4 to 8
A 2. (10 per cent.).....	34 to 38	8 to 17
A 3. (10 per cent.).....	28 to 32	18 to 25
B (7½ per cent.).....	25 to 28	25 to 30
C 1. (5½ per cent.).....	21 to 25	30 to 35
C 2. (5 per cent.).....	18 to 21	35 to 40
C 3. (5 per cent.).....	15 to 18	40 to 50
D (2½ per cent.).....	12 to 15	45 to 60
E (1¼ per cent.).....	9 to 12	20 to 35

The A special hard, A 1, and A 2 grades retain their strength through a great range of temperature. The B and C grades roll and forge hot, and draw cold. The color of these latter grades is similar to 18 carat gold, and retain take and a brilliant polish.

Supplied in ingots, castings, sheets, rods, and wire.

(N. B.—The above-named alloys can be used to advantage by founders for intermixture with their present gun metals, brasses, and bronzes.)

ALUMINIUM BRASS.

This remarkable and cheap alloy is made by combining aluminium copper (aluminium bronze) with spelter in such different proportions as to meet the requirements of the special uses for which it may be employed. It is a close grained, homogeneous, and tough metal, has great tensile strength (up to 42 tons in castings), combined with a remarkably high transverse elastic limit and wonderful elastic resistance.

Average strength, etc., in castings.

Grade.	Tensile strength per square inch.	Elongation.
	Tons.	Per cent.
No. 1	23 to 27	10 to 14
No. 2	36 to 38	8 to 11

Transverse test.—In a bar of aluminium brass No. 2, 1 inch square and 12 inches between supports, the breaking load is 72 cwts., deflection with 44 cwts. load 0.04 of an inch, and the permanent set 0.01.

Aluminium brass forges hot, and, owing to its special casting and noncorrodible qualities, low specific gravity, strength, toughness, and rigidity, is especially suitable for such purposes as ships' propellers, stern and rudder frames, pump plungers and rods, valves, wheels, pinions, etc.; also for hydraulic and engineering work generally where castings are required with a strength equal to or greater than steel.

Supplied in ingots, castings, sheets, rods, hexagons, etc.

FERRO-ALUMINIUM.

This product may be alloyed with molten steel or iron with absolute precision, it forming a perfect alloy with the entire body of the metal. It renders the molten metal very fluid and insures freedom from blow holes, increased tensile strength, and high elastic limit. With castings of steel, cast-iron, and wrought iron, and in puddled bar iron, etc., its benefit is very marked.

Particulars as to results obtained, and as to its use, furnished on application.

The qualities of the ferro-aluminium, as produced by the Cowles Electric furnace, are:

- (1) It may be alloyed with molten steel or iron in any proportions and with absolute precision.
- (2) It forms a perfect alloy with the whole body of the metal.
- (3) It does not burn out or escape from the molten steel or iron, but remains and exerts its valuable influence even after several remelts.
- (4) It can be added in the converter after the blow; in the crucible when it is charged, or by placing the heated cubes at the bottom and pouring the molten steel on top from a second; in the Siemens furnace or in the ladle.

In the using of the alloy it should be broken into cubes of, say 1 to 2 inches, and these heated to nearly or quite white heat and added to the molten iron or steel in the crucible or ladle at the bottom previous to pouring.

SILICON BRONZE.

Invaluable as a flux in all copper castings, and for wire and castings generally. Supplied in ingots, castings, and wire.

HERCULES METAL.

The Cowles hercules metal is a cheaper form of aluminium brass, casts splendidly, and, whilst very hard and strong, works well under the tool; is malleable hot, and suitable for all castings where a strong bronze or brass is required. Tensile strength, 30 to 40 tons per square inch; elongation, 10 to 30 per cent., according to grade.

"COWLES" SPECIAL BEARING METALS.

Grade No. 1.—Hardest composition. This alloy is very noncorrodible, designed particularly for bearings for hard steel shafts, running at high velocities, under heavy pressure.

Grade No. 2.—Hard composition—for all uses, such as crank pin-bearings, slide valves, eccentric straps, foot slips, lathe, and mill bearings, etc.

Grade No. 3.—Medium composition—for railway bearings, freight, passenger, and tram cars, and heavy bearings generally.

Grade No. 4.—Soft composition—for all light-bearing uses.

The base of all these alloys for bearings being aluminium bronze instructions will be furnished founders for mixing with tin, zinc, and lead, to produce the grade required.

Several important firms have used the above-bearing metals and obtained excellent results. A leading London tramway company tested bearings made from grade No. 2 against ordinary gun-metal bearings, and after a year's wear the former were practically as good as on the day they were put on, whilst the latter showed a wear of fully 33 per cent.

MANIPULATION OF ALUMINIUM BRONZE.

The following general instructions for the manipulation and working of aluminium bronze are here noted for the general guidance of our customers:

Casting.—The melting point of aluminium bronze varies slightly with the amount of aluminium contained, the higher grades melting at a somewhat lower temperature than the lower grades. The A grade melts at about 1,700° F., a little higher than ordinary bronze or brass.

Aluminium bronze shrinks about twice as much as brass, and hence due allowance has to be made for this in the mold and pattern. As the metal solidifies rapidly it is necessary to pour it quickly and to make the gates amply large, so that there will be no "freezing" in the "gates" before the casting is properly fed. To obviate the shrinkage as much as possible the metal is allowed to enter the mold at a temperature no higher than will admit of it running freely. Where there is a heavy mass of metal in the shape of an envelope surrounding a core the contraction upon solidification will cause the metal to split unless the core is made to yield equally with the contraction. Baked sand molds are preferable to green sand, except for small castings.

One of the chief difficulties met with in the casting of aluminium bronze is to avoid the oxidation in transferring the metal from the crucible or ladle to the mold. If any of the film of oxide which floats on the surface of the metal should get into the casting during the pouring it will appear there like so much dirt, and is apt to cause trouble. The ordinary skim-gate will prevent this in the case of small castings, but with large masses the metal is first poured into a receiver, which is connected with, and is part of, the pouring "gate," but is prevented from entering the mold by means of a plug which closes up the mouth of the "gate." To illustrate this more clearly imagine the pouring "gate," shaped like a funnel, into which the metal is first poured. It is prevented from running into the mold by the plug already mentioned. As soon as the dirt has risen to the top the plug is withdrawn, and consequently nothing but the clear metal of the bottom enters the mold. For castings over 50 pounds the metal is poured from a large ladle through a hole in the bottom. Ample facilities should be made for the escape of gases.

Both aluminium and copper volatilize only at extremely high temperatures, and consequently aluminium bronze can be frequently remelted without any appreciable change in the strength or quality or the metal whatever. This fact has an important bearing upon the economy of its use.

Like brass, all billets and slabs for rolling into sheets, rods, bars, and wire, are cast in iron molds, but by a method which differs from the usual way of casting brass slabs very materially, and with results far superior to the latter. "Cold shut" edges, rough surfaces, and "blowy" or "dirty" metal, so common to brass slabs, are unknown to slabs and billets of aluminium bronze. Those who are familiar with the rolling, drawing, and spinning of metal will appreciate at once the immense advantages of having perfect stock to begin with. In finely finished sheets the brilliancy and luster to which the bronze is susceptible is not dimmed by speck or blemish of any kind.

Working qualities.—Aluminium bronze is an extremely dense or close-grained metal. The stronger a metal is, or, in other words, the greater the force of cohesion between the particles, the greater the force necessary to overcome that cohesion. For this reason aluminium bronze works harder under the tool than a weaker

metal, which should be expected. But experience soon teaches what is the proper temper for the tool and the right way to sharpen it, and then any difficulty that may appear to those unaccustomed to handling the metal will soon vanish. The fracture of special and A grades exhibit a crystalline structure; the lower grades are extremely fibrous. The former works similar to machinery steel; the latter more like wrought iron.

All the grades, except the special, can be rolled, swedged, spun, or drawn cold, but because of their greater ductility the lower grades can be drawn cold much easier and to a much greater extent before annealing than the higher grades. Aluminium bronze is the only bronze in the arts that is not "hot short," and can be worked at a bright red heat as easily as wrought iron. The advantages accruing from this fact alone are almost too numerous to mention. For gas burners of any kind, tuyères for blast furnaces, or any place where brass and other bronzes will break short when heated to a redness (which, moreover, causes oxidization, and volatilization of the zinc in the former), the value of this bronze becomes apparent. Under the blacksmith's hammer it can be drawn out to the fineness of a cambric needle. The rolling of sheets, rods, bars, and wire is done at a bright red heat, only the finishing being done cold. The only way to harden or stiffen the metal is to work it, but by subjecting it to the proper temperature in the annealing furnace it soon softens again.

Rolling or working the metal in any way makes it stronger and tougher. For instance, the test of a rolled rod of the B grade, tested, showed a tensile strength of 83,000 pounds to the square inch with 39 per cent. elongation before breaking. In the casting this metal has but 60,000 to 65,000 pounds tensile strength with about 20 per cent. elongation. All the grades are perfectly malleable at a red heat, while the special and A grades break less and elongate more than pure copper at this heat. The metal should be rolled at as high a heat as possible below fusion. In rolling, swedging, or spinning cold, it should be annealed very often, else it is liable to break very quickly after it ceases to elongate. It can be made softer by annealing at a bright heat, cooling in still air to redness, and then tempered by plunging into cold water, than by simply annealing.

Small castings of aluminium bronze.—We find it an advantage in making small castings to have the top of the feeder-gate considerably higher than the body of the casting. By the high head or pressure of metal every portion of the mold is filled accurately, and such large spraws for feeding are not necessary.

MANIPULATION OF ALUMINIUM BRASS.

Aluminium bronze, when added to ordinary brass in almost any proportion, greatly improves the brass in strength, toughness, and resistance to corrosion. The more aluminium bronze is added to brass the harder and stronger the brass becomes. Tests have been made where castings of aluminium brass have gone as high as 96,000 pounds in tensile strength to the square inch.

Cost.—It will be observed that the first cost of aluminium brass is much cheaper than aluminium bronze in castings of the same strength by reason of it containing less aluminium than the bronze, besides a considerable quantity of zinc, which is a very cheap metal.

Casting.—Practically the same rules to be observed in casting aluminium bronze (see article entitled Aluminium Bronze) are applicable to the casting of aluminium brass.

Working qualities.—Aluminium brass works under the tool similar to aluminium bronze—those brasses that are high in aluminium working similar to the high grade bronze, those that are low in aluminium like low grade bronze. The working qualities are also governed largely by the quantity of zinc contained in brass—the higher the percentage of zinc the harder the metal and the shorter the chip which flies from the tool.

Messrs. Lehmann exhibited at the Paris Exposition an alloy of aluminium and manganese which had been forged, but of which I was unable to learn the particulars.—W. H. C.

SOCIÉTÉ ANONYME POUR L'INDUSTRIE DE-L'ALUMINIUM, NEUHAUSEN, FALLS OF THE RHINE, SWITZERLAND.

Capital, 10,000,000 francs. Exhibits aluminium, ferro-aluminium, aluminium bronze, forged and rolled and hammered articles of the latter alloy.

This company use the electrolytic process invented by P. L. C. Heroult, of Paris, for the production of aluminium and its alloys. The production of aluminium is not probable by this process, the alloys only being obtained.

The apparatus consists of a wrought-iron box, lined with carbon slabs and having cover of the same. A tap-hole at the bottom allows the withdrawal of the metal. A hole in this cover allows the introduction of the large carbon anode, which is connected with the dynamos by copper cables. The carbon bottom of the vessel is also connected. Copper is introduced into the vessel and the carbon anode is approached to it. When the copper is melted by the current the aluminium ore is introduced, which is melted and floats above the copper. The alumina is decomposed, the aluminium alloying with the copper and the oxygen combines with the carbon anode. The anode is kept as close to the melted copper as possible without dipping in it.

It is claimed that 35 to 40 grammes of aluminium per horse-power per hour are obtained by this process, which is equal to 1 pound for 13 to 11 horse-power. Practice indicated the production of $22\frac{2}{3}$ grammes per horse-power per hour alloyed with copper, forming a bronze containing 22 per cent. aluminium. The power is obtained from a turbine of 300 horse-power.

This company claims to produce aluminium by the Kiliani process, which has not been published. In a circular is given, motive force 4,000 horse-power, workmen 200, annual production aluminium pure 90,000 kilogrammes, aluminium bronze 1,500,000 kilogrammes, ferro-aluminium 1,000,000 kilogrammes.

Aluminium guaranteed 99 per cent., price 25 francs per kilogrammes.

This company received a gold medal.

SOCIÉTÉ ANONYME ELECTRO-METALLURGIQUE FRANÇAISE, PARIS, FRANCE.

Works at Froges (Isere), France. Capital, 650,000 francs. Exhibits alloys of aluminium with copper, iron, and tin severally, in forms of ingots, bars, and sheets. Also silicon copper 12 per cent., and silicon iron.

This company owns the Heroult patents for France.

An American company operates the process at Boonton, New Jersey.

A. R. Pechiney et Cie., Salindres (Gard), France, exhibited aluminium. A communication received from this firm states that they obtain the metals of the alkalies and aluminium by the old process (Deville). From 1874 to 1882 this firm were the only producers of aluminium in the world. Their annual product was about 5,000 pounds.

PITTSBURG REDUCTION COMPANY, PITTSBURG, PENNSYLVANIA.

This company did not exhibit at Paris, but as it is the most recently established company successfully at work, it is proper to mention it here.

This company, established in 1888, uses the patents of Charles M. Hall, date of 1889. Mr. Richards describes this establishment in his work on aluminium.

Two reducing pots of cast-iron lined with carbon are used, the lining forming the negative electrode, and six to ten carbon cylinders 3 inches in diameter, the positive electrode. The pots are 24 inches long, 16 inches wide, and 20 inches deep, holding 300 pounds of the bath. This bath, as now used, is composed of aluminium fluoride, cryolite and fluor spar melted together in the proportions represented by the formula, $\text{Al}_2\text{F}_6\cdot 6\text{NaF} + \text{Al}_2\text{F}_6\cdot \text{CaF}_2$. When the bath becomes clogged it is cleared by adding 3 or 4 per cent. calcium chloride. The bath is kept melted by the electric current, nearly at the melting point of brass. During the operation, alumina, obtained from aluminium hydrate, is fed in, and this only is decomposed, the fluoride solvent wasting only slightly. In making alloys, as bronze, both electrodes are of copper. The bronze formed at the cathode drips down melted to the bottom of the vessel. About a pound of aluminium per hour is produced in each pot, and the operations are kept up without stopping for several weeks at a time. A 50 horse-power engine driving two dynamos effects the reduction, this is equal to about 20 grammes per horse-power per hour. This is about 300 pounds per week. It is said a plant is to be erected of a capacity of 2,500 pounds per week, and one of the same size in England.

This company offer their aluminium at \$2 per pound. Mr. Richards estimates the cost of this metal at \$1 per pound, with the large plant at not over 50 cents.

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REPORT ON FIBER CULTURE AND MACHINERY.

LETTER OF SUBMITTAL.

WASHINGTON, D. C., *March 1, 1890.*

SIR: I have the honor to submit herewith a special report on fiber culture and machinery in Europe, prepared in accordance with instructions from you, which also included commissions to visit the flax and hemp regions of France and the principal flax districts of Belgium. In carrying out your instructions, as far as the field studies are concerned, while I was able to personally examine into the methods followed in these countries, in the handling of the product after the harvest, information regarding culture could only be secured by inquiries upon these subjects among the well-informed people who were met in my travels. It has been necessary, therefore, in some instances, to amplify this information, and in a few cases to supplement it, by quotations from authoritative works on the subject. I attended the ramie machine trials, in Paris, as you are aware, and have embodied the results of these trials in the report, with such descriptions of the machines submitted to the jury, and other general matter, as has been thought of interest. Statements relating to matters of special interest in the treatment of flax, which were investigated at the Exposition, are also made in their appropriate places. Before closing, I wish to tender acknowledgment to the following persons, in France and Belgium, to whom I am under obligations for kind assistance rendered in various directions: In Paris, to Mr. Leopold Faye, minister of agriculture, Mr. Eugene Tisserand, director of agriculture; to Messrs. Henri Grosjean and Henri Mesnier connected with the ministry of agriculture. To Messrs. P. A. Favier and Alfred Renouard, jr., and to Mr. Amory Austin of the American Commission. In Le Mans, Sarthe, to Prof. E. Dupont. In Belgium, to Mr. Frederick d'Hont, of the communal laboratory of chemistry, Courtrai; to Mr. Paul DuVuyst, of the state agricultural inspection, and to Prof. A. Damseau, of the state agricultural experiment Station at Gembloux, to whom I am especially indebted for all that made my brief visit to Belgium so pleasant and profitable.

And lastly, I take the opportunity to thank you, not only for your appreciation of, and assistance in, the work undertaken, but for the uniformly courteous and kindly treatment received from you in my relations with the American Commission in Paris.

I am, sir, yours, respectfully,

CHARLES RICHARDS DODGE,
Member of the International Jury.

Gen. WILLIAM B. FRANKLIN,
Commissioner-General to Paris Exposition of 1889.

THE FLAX AND HEMP INDUSTRY IN FRANCE.

By CHAS. RICHARDS DODGE.

The cultivation of both flax and hemp is declining in the French provinces devoted to these important agricultural industries, for the simple reason that in many localities it does not give a sufficient money return to the cultivators. It is said that a French flax grower must receive \$48 per acre for his crop to save himself from loss, whatever amount he receives above this figure constituting his remuneration. Undoubtedly competition with Russian fiber, of both flax and hemp, has had something to do with the inability to secure paying prices for the product when grown in many less favored localities, though the employment of cotton in increasing amounts from year to year by the spinners, in goods taking the place of linen fabrics, has been an important factor in the decline. This has been especially so in regard to hemp, which formerly was almost universally used in portions of France, particularly the western part, in the domestic economy. Naturally, then, under a double competition, prices have been forced down to that extent that on many fiber farms the cultivation has had to be discontinued for more paying crops.

There is much in the French practice, however, that is worthy of being followed in our own country, where of late fiber industries are attracting considerable attention, and it was for the purpose of learning something of foreign methods that I visited the centers of these two industries during the past summer, hoping that American flax and hemp culture might benefit from the information secured.

FLAX CULTURE.

Flax was formerly grown in the departments of Pas-de-Calais, Côtes-du-Nord, Finistère, Loire-Inférieure, Nord, Vendée, Gers, and others. The department of Nord was, and still is, the center of this cultivation, the city of Lille being the seat of the industry. I learn that since 1875 the culture has ceased entirely in the districts of Cambrai, Valenciennes, Avesnes, and to a great extent in Douai. It has largely diminished in the same time in the districts of Dun-

kerque and Hazebrouck. Around Lille, however, there has been no falling off, owing to the near proximity of this district to the river Lys, a Belgian stream, famous for the retting of flax.

In the first place, a most systematic practice is followed regarding the matter of rotation of crops. It is customary to divide the arable lands of the farm into many subdivisions or lots, this parceling of the area being termed *assolement*. Regarding the specific crops that are grown on these subdivisions each season a careful record is made, so that flax will follow and be followed by certain crops at stated periods, not only in order that there may be no exhaustion of the soil, but that it may be put in the very best condition for the production of fibre. Mr. Renouard says, tersely, "Flax takes all from the soil, but returns nothing; for this reason cultivation can not be followed without danger in the same field save after long intervals."* A common rotation is flax once in 9 years, with the following crops: First year, rape; then wheat, followed by potatoes; for the fourth year, wheat and clover; fifth year, clover, the plot being devoted the next season to beans or potatoes, or to the culture of beet root; oats follow in the seventh year, and then comes the season for flax, with wheat again the ninth season, and so on. In another rotation, tobacco is grown the second year, and the order of the other crops is changed somewhat, though oats and wheat precede and follow the flax crop, as in the first instance. Nor is either of the above followed absolutely, as each farmer has his own ideas upon the subject, and varies the rotation to suit the peculiarities of his soil or other condition of his locality.

A thorough soil preparation is considered absolutely essential to success. This begins with plowing the soil deeply in November. On clover land one fall plowing will suffice, though soils that do not yield readily to the action of frost are plowed twice. In spring, when necessary, another lighter plowing is given, after which the surface is harrowed until all clods are broken up, and when reduced to a fine state of tilth the roller is used to compact the soil and make it perfectly level.

It may be of interest to note in passing two special methods said to give excellent results, which were formerly employed in the north, but which Mr. Renouard states have necessarily been generally abandoned because of the expense connected with manual labor. I give them entire:

One of these methods, which was sometimes used for cereals, was called "aërated soil" or "overturned soil;" the other, employed especially for flax, was the system of covering. The first is executed by means of the plow and the spade. The operation consists of digging through the extent of the seventh furrow an interior trench, or throwing up a secondary line of earth from the bottom of the plowed furrow by means of an iron spade, and throwing this soil upon the top of the lines of earth

* Studies on Flax, by Alfred Renouard, jr.

already cast up by the plow. This process is continued in the same manner as the work advances. These interior trenches are thus at a distance of 2 metres apart, while the draining ditches or open trenches (which are always indispensable) are about 8 metres apart.

As soon as the process of throwing up the earth for this interior trench is completed the plowman covers it immediately by a deeply-cut furrow, then diminishes little by little the depth of these trenches until the seventh furrow is reached, where he commences another deep cutting. In this manner the plowing continues to diminish in depth and forms a sort of slope which inclines toward each new trench, leaving the soil in a perfectly healthy condition. This method of operating involves an expense of about 20 francs per hectare* and requires about eight men to do the work. It presents the advantage of rendering the soil very clean and less compact, thus being more suitable to the use required, as well as being impregnated with the fertilizing gases of the atmosphere and in condition to absorb the rains.

The second manner of preparing the ground, the "covering," consists in having the plowman followed by five or six men who remove a spadeful of earth from the bottom of each furrow at intervals of 25 to 30 centimetres, which earth they place vertically between the two furrows which have just been plowed. Care must be taken to leave the drainage-ditches open at distances of from twenty-five to thirty furrows, according to the nature of the soil. It is the same principle which governs the preceding method.

The earth brought up in this manner from the lower stratum is still fresh unused soil, and coming to the surface it is mixed with old manure, and also becomes quickened by the atmospheric gases, to the influence of which it is exposed all winter, being in the spring ready for the seed which is designed to be sowed. It is also by this means crumbled and pulverized.

The fertility of the soil must be well kept up, and it is a principle that it pays far better to sow in ground which has been heavily manured the previous year, even if manured to excess, than on one which has had only the average fertility. In addition to the chemical manures and the usual manures of the farm, ground oil-cake is used from rape, hemp, and poppy, and even night-soil, though the latter is reduced to a liquid form. Great stress is laid upon the importance of spreading the manure evenly, not only that the flax straw will be of uniform length, but that the fiber itself may be of even quality.

As to the amount of fertilizers used, while this depends somewhat upon the condition of fertility from the previous season's manuring, the general practice is to manure heavily, or at least the average American farmer would so regard it. Of oil-cake alone, when employed, the ordinary practice is to use about a ton to an acre. When guano is used, though this is not considered altogether a desirable fertilizer for flax, not more than a third the above amount per acre is employed.

Chemical fertilizers, in which there is a predominance of nitrogen, potassium, and phosphoric acid, and some magnesia, in condition to be taken up at once by the plant, are regarded as the most valuable to use on this crop. They are spread a week or two weeks before

* About \$1.60 per acre.

the last plowing, and the ground oil-cake, not being so readily soluble, is applied to the ground several weeks earlier. The cost of manures per acre varies from \$8 to \$16, reduced to American currency.

The next consideration is seeding. Early-sown seed gives the best results, the proper time to sow being from the middle of March to the first week in April. With some, however, flax is sown much later—say from the beginning of the last week in April to the end of the first week in May. Late-sown flax, however, does not do so well, as it ripens more rapidly, and it is stated that the crops from both early and late sowings are harvested about the same time. In the department of Nord nearly 3 bushels of seed are sown to the acre. On strong soils, however, when a strong stout flax is desired, a less quantity is sown, and naturally, to produce a crop of seed, a still less quantity. The thicker the sowing in a thin though finely-pulverized soil, the finer the fiber that will be produced.

The seed is generally sown broadcast and afterward is carefully rolled. Mr. Renouard states, however, that small farmers planting an acre or two of land, use instead of the roller what is known in French as *coquettes* (*coquer*). These are pieces of board measuring $7\frac{1}{2}$ inches by 15, which are bound upon the feet by means of cords or straps, and thus shod the farmer goes over every foot of ground he has seeded, and by the pressure from his own weight he compacts the soil in the same manner as when it is rolled. It would be difficult to imagine an American farmer following any such laborious practice, even on half an acre of ground; but the foreign laborers are painstaking and thorough, if they are slow. The seed usually comes from Riga, though some Dutch seed is sown.

No weeds are allowed to exist in a French flax field if it is possible to prevent their growth. Great care is taken when selecting the seed, and finally before sowing, to avoid sowing with it the seeds of weeds. The soil itself is kept as free from weeds as possible, and after the flax plants are up 2 or 3 inches high the weeds that have already shown themselves are destroyed by hand labor. As is the custom in most foreign flax-growing countries, much of the work is done by women and children, who work against the wind, in order that the plants may be blown into an upright position again after the weeder pass along. To avoid going back and forth or up and down over the field many times, and at the same time to accomplish the work quickly, a line of weeders start down the field side by side, so that when the farther end is reached a considerable strip has been cleaned, that will not need to be trampled again. The weeders are armed with knives, with which the young weeds are dug up, and the work is usually done upon the knees, the shoes or sabots having been removed from the feet. Sometimes a second weeding is necessary, but it is given very soon after the first, for the plants are never

disturbed after they are 4 or 5 inches high. The weeding finished, the crop is allowed to mature, for nothing further can be done until harvest time.

As to the manner of growth, and even as to quality and yield, much depends upon the season, and in this connection there are many happy sayings, usually in rhyme, which embody a considerable amount of experience. I find a number of these in "Studies on the Culture, the Retting, and the Cleaning of Flax," a few of which are quoted:

Quand Mars bien mouillé sera,
Bien du lin se récoltera,

refers to a wet March, from which it is inferred that much flax will be gathered. Another assures the grower that if February is a wet month the flax will be good. There is one which refers to the benefits from sowing flax after a crop of hemp, which, by the way, would prove an admirable general practice in our own country, hemp is such a positive weed extirpator. Here are the lines:

Si tu sèmes ton chanvre en un riche terrain
Tu tiens déjà de lin récolte en bonne main.

Or, in plain English, "If you sow your hemp on rich land, you have the flax harvest well in hand"—both truth and rhyme. "Cold May, long flax," is another.

To come back to our starting point, after weeding there is nothing to do but wait for the harvest, and "it is June that makes the flax."

C'est Juin qui fait le lin.

The flax is usually pulled when the blossoms have fallen and the leaves of the plant have begun to turn yellow. Sometimes it is left for a later period; but for the production of fine flax the practice is said to injure the fiber. The precise time to pull is a matter which must be determined by the farmer's judgment and experience, though it rarely is put off later than the last week in June or first of July. In pulling as much of the root end is secured as possible, for this is considered the best part of the flax straw. This is the part which American practice, where the machine reaper is used in the harvest, is left in the ground in the form of stubble.

As the handfuls of straw are pulled and well shaken they are laid across each other to be taken up by the attendants who follow, who set them up for drying. This is usually accomplished by making two lines of flax, inclined toward each other and interwoven at the top, in the form of an inverted V (or Λ), resembling what is known as an "A tent" and extending some 10 feet in length. The only caution necessary in this operation is to keep the flax loose, so that the air can circulate freely among the straw and dry it evenly. On account of its liability to injure at this stage, the flax is never bun-

dled or thrown into piles until thoroughly dry. When dried it is made into bundles and stacked.

I found the methods practiced in this part of France (the Lille district) were very similar to those followed in the Courtrai district of Belgium only a little north of here, and was surprised to learn also, that a great deal of the straw (all the best flax) is transported to the river Lys to be retted in the opaque and dark-greenish waters of this famed stream.

As in the Courtrai region, very few farmers have anything to do with marketing their flax, selling the crop to the merchants in the field, just as some New York State orchardists dispose of their apple crops to the dealers, who send their own men to gather the fruit.

These brokers, or their agents, often drive hard bargains, so that the matter is not settled without considerable discussion, of course after due examination of every part of the field. In regard to these bargains, Mr. Renouard says "that which grows along the edges of the field is deducted, and frequently two or three of the poorest hectares count for nothing. A very good crop will bring the equivalent of \$150 per acre, and in past time as high as \$200 an acre has been paid. But there are "ups and downs" in this business as in everything else, and sometimes a farmer only gets \$40 for a poor crop and then he is out of pocket.

"After the crop is sold it is in charge of the buyer, though it is customary for the farmer to send the flax to the home of the buyer, it matters not how distant it may be. In some cases it is sold to be delivered during the May of the next year. The flax is put up in stacks by the farmer, for the winter, and the seed carefully preserved in the barn for the buyer until the time for delivery. Under such conditions the sale is made by the kilogramme, and at prices varying from 10 to 30 centimes, there being 3,500 to 4,000 kilogrammes of stalks per hectare." This is equivalent to about 5 to 15 francs per cwt. or \$1 to \$3, there being from 32 to 35 cwt. of straw to the acre, or an average of \$67 per acre.

In separating the seed from the straw, the capsules are broken by beating, or the heads of the bundles of straw are whipped through coarse iron combs, which are simply a row of sharpened iron spikes inserted into the center of a rude bench. The two workmen sit astride of the bench, facing each other, and armed with a handful of straw, each in turn strikes it down between the teeth of the comb or rack, and drawing it toward him the capsules are broken and the seed falls. When beaten out, a rectangular block of wood, with a long handle, is employed, the straw being spread out upon the floor of the barn or shed. There are several machines also, for accomplishing this, some employing the beater principle of crushing through heavy rollers, which will be described in the chapter devoted to Belgian flax culture. After the seed is secured it is care-

fully dried so as to avoid all danger from dampness, and is then stored.

The next operation is that of retting, and is conducted both in water and upon the ground, the latter method being similar to that most commonly employed in our own country. The best flax of France is produced by retting in running water, precisely as it is done in western Belgium, and in practically the same waters. I did not see this form of retting in France, so will describe it as it was witnessed at Courtrai, just over the border into Belgium, where probably the finest flax in the world is produced, from immersion in the river Lys. The French flax growers, in Nord, carry on the *rouissage* or retting in the Lys and in the Deûle, the latter being a branch of the first-named stream.

Mr. Renouard states that retting in the Deûle commences at a hamlet called Justice, facing Ouesnoy-sur-Deûle, continues past this town, and at a distance of 3 kilometres from there rejoins the Lys at Deûlemont.

At Deûlemont but little retting is done. This work properly so called, begins at the hamlet of Pont-Rouge which is adjacent to this commune, continues past Warneton and, with a few interruptions, reaches to Gand in Belgium. The communes where retting is carried on upon the borders of this river, are, after Warneton, Comines, which the Lys separates into two parts, Comines-France upon the right shore and Comines-Belgique upon the left shore, then Wervicq, where there are a great number of spinning machines for flax thread which receive the raw material from this vicinity, and finally Bousbeques, the village of the department of Nord where the greater part of the retting and working up of flax is done. After Bousbeques we find some retting places near Halluin and we enter Belgium at Menin. The extent of the retting places upon the French border reaching to the Belgian frontier is 11,300 metres.

Down the river from Menin and after Courtrai the Lys is bordered by scarcely anything more than small market towns of little importance. The most populous villages are in the interior. On the west of the river far from the shore are the cities where the flax industry in manufacturing the flax of Belgium is most extensive.

Ingelmunster, Harlebecque, Iseghem, Meulebecke, Roulers, Thielt, etc., and on the south Cruishautem. In Belgium the extent of the retting works on each border is 106 kilometres (65.72 miles). It is well known that formerly the retting waters flowed directly to the city of Gand and produced in that place nauseating emanations which provoked repeated complaints from the inhabitants. At present the waters of the Lys are divided from the city and enter the sea via the canal of Schipdonek.

In Belgium, as in France, the retting process in the Lys is done in identically the same manner; we shall, therefore, have no distinction to make in our description. The work is confided to men who make a specialty of this occupation as a profession, and who either own or rent a certain number of fields for the drying of the flax.

Some operators, before putting the flax into the *ballons*, do the sorting over of the stalks. They put the short stems one side, they being more difficult to ret than the long ones, also the broken or injured stems, as they can not remain as long in the water as the perfect stalks. This operation when it can be done is the reason of the reputation which the flax of the Lys has for its regularity so well known.

I visited Courtrai about the 1st of September, at which time the retting in the river Lys was in full operation. Through the courtesy of Mr. Frederick D'Hont, director of the communal laboratory of chemistry, etc., I was enabled to study not only every phase of this portion of flax preparation, and to talk with the men who were engaged in the various operations in the handling of the straw during the processes of retting and drying, but to follow the product to the scutch mills, and witness the operations necessary to convert the shining golden straw into merchantable flax.

In this form of retting, that is, immersion in running streams, it is first necessary to prepare a kind of crate or framework of wood, to keep the bundles of straw in position. These are about 12 feet square, or perhaps 12 by 15 feet, and perhaps 3 feet deep, called "*ballons*." They are provided with a floor of boards, and to the corner posts are nailed strips about 4 inches wide, one set running around the top, another midway between the top and bottom, and a third set at the bottom, with other strips running across from side to side, at intervals, to strengthen the framework, as the affair is constructed to hold some 3,000 pounds of flax straw. Before the bundles of straw are placed in position a strip of burlap is secured to the four sides, on the interior, to protect the straw from any dirt or scum that may be contained in the water or floating on its surface. The bundles of flax, measuring some 10 inches in diameter, are made up of smaller bundles, laid end to end in such manner that root and seed ends alternate with each other, making a mass of straw of equal diameter throughout. As the frame rests on the bank of the stream, one side lower than the other, the work of packing in the bundles, each one being placed on end, is easily accomplished, the workmen packing them closely, often beating them into position with his fists, so that no interstices will occur, and no bundles will be loosely placed. When the crate or "*ballon*" has been filled, the entire mass of flax is covered with clean rye straw, and it is floated into the stream, towed to its place and anchored. It is then weighted with paving blocks or other stones until it has sunk to the top rail, when it is left for the softening action of the water to accomplish the retting. The time of immersion is never less than four days, and it may be continued for fifteen days, as there are many conditions which have to be taken into account, as the season of the year and the temperature of the water, the quality of the straw, etc. The precise time to remove the straw from the water is indicated first by the rising of the crate out of the water, sometimes exposing a third of its height, but more positively by the condition of the straw itself, as indicated by examination and tests from time to time. These tests can not be readily explained, as a knowledge of the proper condition is gained only by experience.

When the flax is ready to remove, the "*ballon*" is hauled out upon

the bank by means of a windlass, and the unpacking begins. As the bundles are taken out they are opened, and the lesser bundles or "beets" conveyed to the field back from the river, where they are opened out from the bottom and set up on end, resembling little circular tents, a wisp of straw dexterously twisted about the seed ends of the straw holding it together. After the flax is thoroughly dry it is again put into bundles for a second retting, and the operations of immersing into the Lys once more gone through with, followed, of course, by another careful drying when the flax is ready for the scutcher.

The work is done from March to October, though if the latter month is cold the retting is not so thoroughly accomplished, and the straw must remain in the water a longer time. A great deal of the flax of one season is not retted until the season following, but it is put into bundles and these into immense circular stacks or ricks, protected from the weather by thatching.

Retting in running water is practiced to a slight extent in other parts of France, a portion of the flax of Brittany being treated in this manner. It is not so carefully done, however, as in northern France, the farmers performing the work themselves, and to avoid extra labor, or to make way for other harvests, it is retted but once. Pool-retting, or retting in cemented reservoirs (*routoirs*) is also practiced in this part of France; and there is a third form of retting, referred to by Mr. Renouard under the name of the "Homon process," from its inventor. This gives the "gray flax." The method is described as follows:

It consists in spreading the flax, with its seed, upon the field as soon as it is gathered, and leaving it there from 10 to 15 days, and afterward putting it to ret in running water or in cemented *routoirs*. After this it is dried upon the field, and when dry is stored. This method consists, in fact, of a modification of the double retting employed in "Nord," by first retting in the field and afterward in water. As soon as a considerable number of flax cultivators in Brittany knew of this process they immediately adopted it in preference to the retting in water, assuming that after the retting on the field they had always to get out the seed at once, before putting the flax into water, while in the process of water retting immediately after gathering the flax, as is done ordinarily, they were certain to lose the seed.

Among the objections urged against the practice is that a poor quality of fiber is obtained. Three grades of flax are made—one well retted, another only partially so, and a third scarcely retted at all. By continuing the process in water, the first becomes over-retted and there is waste, the partly-retted is soon ready to be removed from the action of retting, while the third is nothing like the other two when the work is finished.

In the Flemish process, as practiced in Brittany, the cultivator has always in the first retting all the uncertainty belonging to the method employed upon the field, he can not judge, therefore, of the degree of retting required in the second operation which he must submit his flax to, and therefore must act simply in a manner wholly

experimental. We are told that a large number of cultivators in Brittany have adopted the Flemish method under the pretext that the retting on the ground gave them time to gather the seed from the flax and preserve it, because when the weather was favorable the seed became perfected by being spread upon the field, while where it was gathered after the flax had been retted and placed in water immediately after being harvested, the seed was inferior and could not be sold to advantage. All this may be true, but it must be conceded that it would be very easy for the cultivators in Brittany to gather their flax later, to dry it and shell out the seed, and to ret it well in water afterward.

This detailed statement may seem unimportant to the American reader, but it is worthy of note that Western flax growers in our own country have been advised recently by the Department of Agriculture to follow the closing suggestions in order to preserve both seed and fiber. As is well known, the Western flax farmer grows for seed alone, cutting his flax with the machine reaper, thrashing it with the ordinary wheat thrasher, and burning or at least wasting the larger part of the straw, or if any is sold for fiber, it is sold from prices ranging from \$2 to \$6 per ton to make a very coarse kind of tow for upholsterers' use. If the practice suggested above will give the Breton farmer his flaxseed and also enable him to obtain the fiber, even though not of the highest grade, can not the American farmer take a hint from this practice and obtain in addition to the seed from his crop—which now pays for the crop at a good profit—and secure also a good quality of straw that will give him fiber fit for some of the coarser manufactures of linen?

To accomplish this he has only to follow foreign methods to the extent of better soil preparation, more careful selection of seed (importing the Dutch or Riga seed), pulling, or cutting close to the ground, keeping the straw straight without breaking it in taking off the seed, and lastly, by adoption of a careful system of retting, and with experience his "worthless straw" rises in value from an average of \$3 to \$30 and \$40 per ton, and for the cleaned fiber from \$80 to \$150 per ton.

To return to the French systems of retting, "*rouissage au plat*," or retting "on the level," refers to a system of drying in the field, to begin with, until the seed is cured, when it is rippled and the flax put into bundles. These are floated on the surface of the water and turned every day by an attendant until the straw is completely retted. This process is little practiced in France at the present time.

Another plan is to ret it in turf-pits or the excavations made in the ground by the removal of turf or peat for fuel. These become filled with rain water, like the "bog-holes" of Ireland, and through the influence of the soft water, which may be charged also with organic matter taken from the turf, excellent results are obtained. This process, also, is but little employed at present.

This leaves only the process of dew retting to be considered—that of spreading the straw upon the fields in the manner almost univer-

sally practiced in America. I learn that this form of retting is still followed in Picardy and Normandy, throughout the entire south, and in sections of the department of Nord. We need not give any extended mention of this practice at the present time, however, as American flax growers are already familiar with its details.

A word before closing upon the method of retting in cisterns or *routoirs*, which has been before referred to. These cisterns are described as closely-cemented vats open at the top, from 14 to 20 feet in length by 10 to 14 in width, and perhaps $3\frac{1}{2}$ feet deep. They are managed as follows:

The flax is in bundles, which are placed upright in the vats. These are prevented from rising by crosspieces, and condensed steam is then applied from a steam-engine, cooled to a point not warmer than 30° to 35° C., until the cistern is entirely filled. Finally there is allowed to run in at the bottom a light stream of tepid water, and this causes the surplus water to flow over the top. In these conditions the process of retting may last 4 days upon an average.

In Brittany there are many of these cemented cisterns or *routoirs*. The flax is pulled early, the seed sacrificed, and the straw taken directly to the vats without being dried. These cisterns are immense basins, rectangular in form, and built of stone (granite), and contain about 10,000 kilogrammes of flax in the stalk, and are generally situated near a spring.

The disadvantage of this system, it is remarked, is that the flax is retted at one operation. As so much stress is laid upon the double retting in those localities where the finest fiber is obtained, it would be well for the American flax grower who may try to produce fine flax to make a note of the benefits of subjecting flax twice to the retting action with a period of drying between. As the after processes relate more to manufacture than to cultivation, the subject as it relates to France may be discontinued at this point.

HEMP CULTURE.

Toward the latter part of September I visited the hemp region of western France, spending a week in different localities in the departments of Sarthe and Ille-et-Vilaine, the hemp culture of this country being carried on for the most part in the section of France known as Brittany.

I was much interested to learn that there was a large demand for hemp for spinning purposes, smaller now than formerly, because cotton has come into such universal use, but still enough to make quite an industry in the production of hemp "linen" alone. This manufacture includes shirtings, sheetings, and similar "white" goods, canvas, and a number of coarse fabrics which find a ready market. Some of the fabrics examined, which had not been bleached, were creamy in color and so firm and durable that one readily understands why they still find employment by the Breton peasants in the domestic economy. The larger demand for hemp fiber in this section,

however, is for the manufacture of cordage, the seat of this manufacture, and the seat of the hemp industry as well, being Angers, in the department of Maine-et-Loire. For lack of time I did not visit Angers, appreciating the fact, also, that it was hardly important to do so, because I was able to learn all that I desired to know in the localities that were visited. Methods of culture and of handling the product after harvesting are practically the same as were followed many years ago, a gradual decline in quantity produced being the principal change that may be noted in the industry.

Probably the finest hemp is produced in Italy. The French hemp resembles this somewhat in color, both being a creamy yellow and soft and fine. The Russian and American hems differ from these, being dark in color and not so fine in quality, though it is possible to improve the quality by better methods in both countries. While there is room for improvement in our own country, it would seem unnecessary to produce a hemp for spinning into fabrics to compete with flax manufacturers when there should be a good home demand for a large quantity of coarse hemp, and the flax industry in the United States needs encouragement for the production of a grade of fiber for the very fabrics that hemp would enter into. Nevertheless it is interesting to know how the French hemp is produced, and the main purpose of my investigations was to obtain information in this direction for the benefit of American farmers.

The prominent departments of France where hemp is cultivated are Maine-et-Loire, Sarthe, Morbihan, Isère, and Puy-de-Dôme. The two varieties cultivated are the common hemp of the country and the Italian hemp, the seed of which is obtained at Piedmont, the chief difference being in the length of the stalk, in slower development, and in its coarser quality, making it better adapted for cordage.

The soil of the lowlands, as the valleys and river bottoms, gives the best results in this culture. A moist but not a wet soil is essential, and limestone soils are most favorable. On the contrary, very light or dry soils, or those that are heavy and tenacious, are not favorable to success.

As in flax culture a thorough preparation of the seed bed is important, and the finer and more mellow the ground the better will be the fiber. The first plowing is done in summer after the harvest of the previous crop, for hemp is not considered an exhaustive crop, and is frequently grown upon the same land for a succession of years. I was not able to witness any of the agricultural operations in this industry, as it was late in the season, but the plowing is thus described:

The earth is thrown up so as to form two trenches of 0.30 metre (about 1 foot) in width, letting it fall over a strip of ground likewise of 0.30 metre in width, and which is completely covered by the earth thus thrown up. The heat at this season is sufficient to soon destroy the weeds contained in the earth thus thrown up and

overlapped. Ten or fifteen days later a roller is passed over the ground to level it, and a portion of the fertilizer is spread, then about $2\frac{1}{2}$ hectolitres* of beans are sown to form a green compost. After this a second plowing is given, but in a reverse manner from the first; that is to say, the strips of ground which had been left at the first plowing are now turned over. The roller is again passed over the rough earth and draining ditches are made to prevent any moisture from hindering the plowing, which should terminate this series of operations at the end of autumn. This last tilling is done when the beans are 16 to 18 inches high and before the frosts.

The harrow and roller are used to mellow and compact the soil, and small lines of trenches or furrows are dug for drainage purposes, these leading into the transverse ditches. These lines are about 10 feet apart. No further preparation is needed until the time for sowing the seed. Just before this time arrives the ground is worked over to kill the weeds, and is again harrowed. The seed is sown in drills, and covered lightly with a hoe, the soil being pressed down and made compact with this implement. The sowing occurs in the north of France about the last of April. The best fertilizers to use in hemp culture are ground bone, animal charcoal, lime, marl, and compost mixed with ashes. It is considered an advantage, likewise, to return to the soil the leaves and woody matter after cleaning, as well as the water in which the stalks were retted, when this is possible.

As the seed must be sown quite thickly to produce fine hemp, it deteriorates rapidly and involves the necessity of frequently renewing the seed; this causes a considerable expense. In order to retard as much as possible this impairing of the quality, there are a certain number of feet, upon the borders of the field, thinned out, and maize, beet root, etc., sowed so that the plants, being isolated, may acquire a large development and the seeds produce plants which will preserve the proper characteristics of their species. The good seed is of a dark gray color, glossy and heavy. It preserves its germinating power but one year.

As to quantity of seed sown per acre, a difference is made regarding the use to which the fiber will be put, a third more seed being sown for spinning fiber than for cordage fiber. On a farm which was visited in Sarthe, a little less than 3 bushels of seed is sown to the acre. In general terms, therefore, from 3 to 4 bushels of seed is the proper quantity. Where the ground hardens too rapidly, after sowing, and before the plants have started, straw is sometimes strewn over the field, or the rake is used to keep the surface open.

In harvesting the stalks are either pulled, or they are cut with a kind of short scythe, the time being about the middle of July. The cut stalks are left on the ground several days to wilt, when the leaves are taken off and they are put into bundles for retting. This is the practice when cordage fiber is desired, the stalks always being pulled if the fiber is to be used in spinning. The leaves are stripped in this

*The area was not stated, but it is supposed that this quantity was for a hectare, which would be equivalent to $2\frac{1}{4}$ bushels of beans to the acre.

case before the plants are removed from the soil, a handful of stalks being pulled at a single operation.

Hemp is retted both in running and standing water, and also by spreading upon the ground, the latter practice being the method followed in the United States, and therefore needing no special description here. The water retting gives the best results, producing a better color of fiber, running water, especially, washing out all impurities and waste matter as they are dissolved and separated; but the water must be pure and free from any mineral constituents which might discolor the hemp in the process of retting.

In the sections visited by me almost the universal practice is to ret in the running streams, as in the river Sarthe and its tributaries, although I understand there have been great objections to the practice on account of the contamination of the streams at the retting season, and indeed there are police regulations prohibiting it. The time required for the retting is from 5 to 8 days, though a less number of days suffices when the product is retted in pools or stagnant water. This is due partly to the higher temperature of the pools, as the cooler the water the longer the period required for the retting.

When the stalks have been in the water a sufficient length of time—indicated by their appearance when broken, the farmer frequently testing them in this manner—they are removed and taken to the field to be dried. This is accomplished by placing the bundle of stalks on end, opened out at the bottom, the tops being held together by simply slipping up the band which has served to hold the bundle together in the water. In two or three days the drying is completed. Before breaking out the fiber, however, it is customary to give the stalks a more thorough drying in brick kilns (built in the form of round towers, 10 feet high and perhaps 8 in diameter). The kilns visited were full of hemp bundles standing on end; yet as no fire was to be seen I inferred that the kilns are heated before the hemp is put in, the heat of the bricks being sufficient to evaporate all moisture.

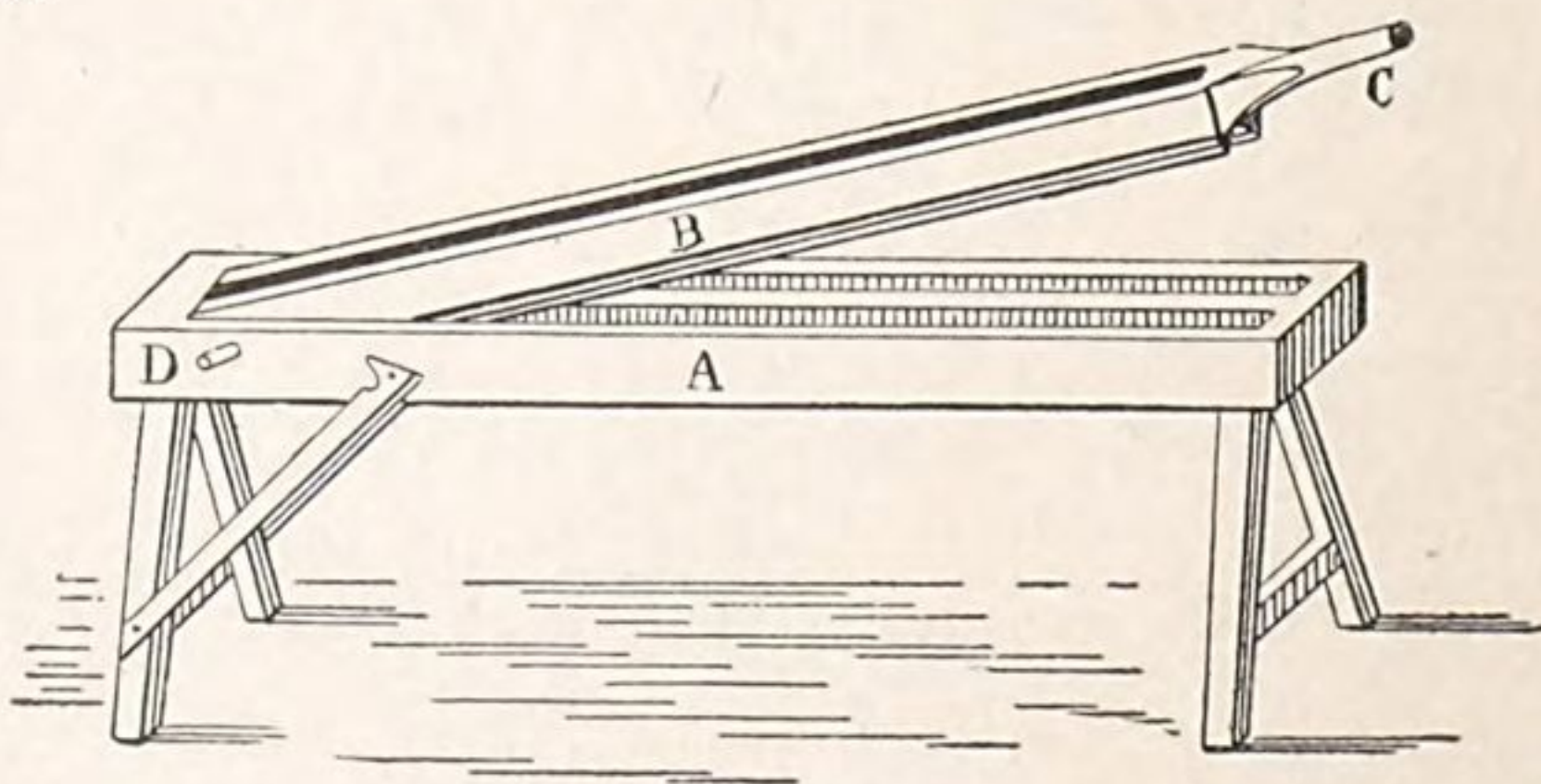


FIG. 1.—French hand brake for hemp.

The French brake is only a slight advance upon that used in Kentucky, being smaller, composed of both metal and wood, and having

seven instead of five slats. It is a less clumsy affair; yet a French workman can not clean more than half the quantity of hemp in a day that the average Kentucky negro operator produces. Thirty to 35 kilogrammes of fiber per day is the limit of production for a single brake in France—that is, 65 to 75 pounds. It is more carefully prepared however, the fiber being twisted into small “streaks” or loose ropes, a number of these making up a bundle of several kilogrammes’ weight, which is the form in which this hemp goes to market. From the farm the hemp goes to the hacklers to be dressed, although that which is intended for spinning into cloth is first softened at the softening mills, where the fiber undergoes a pounding for several hours under ponderous cone-shaped iron rollers revolving in a circle. At a hemp-softening mill (*batteur de chanvre*) near Le

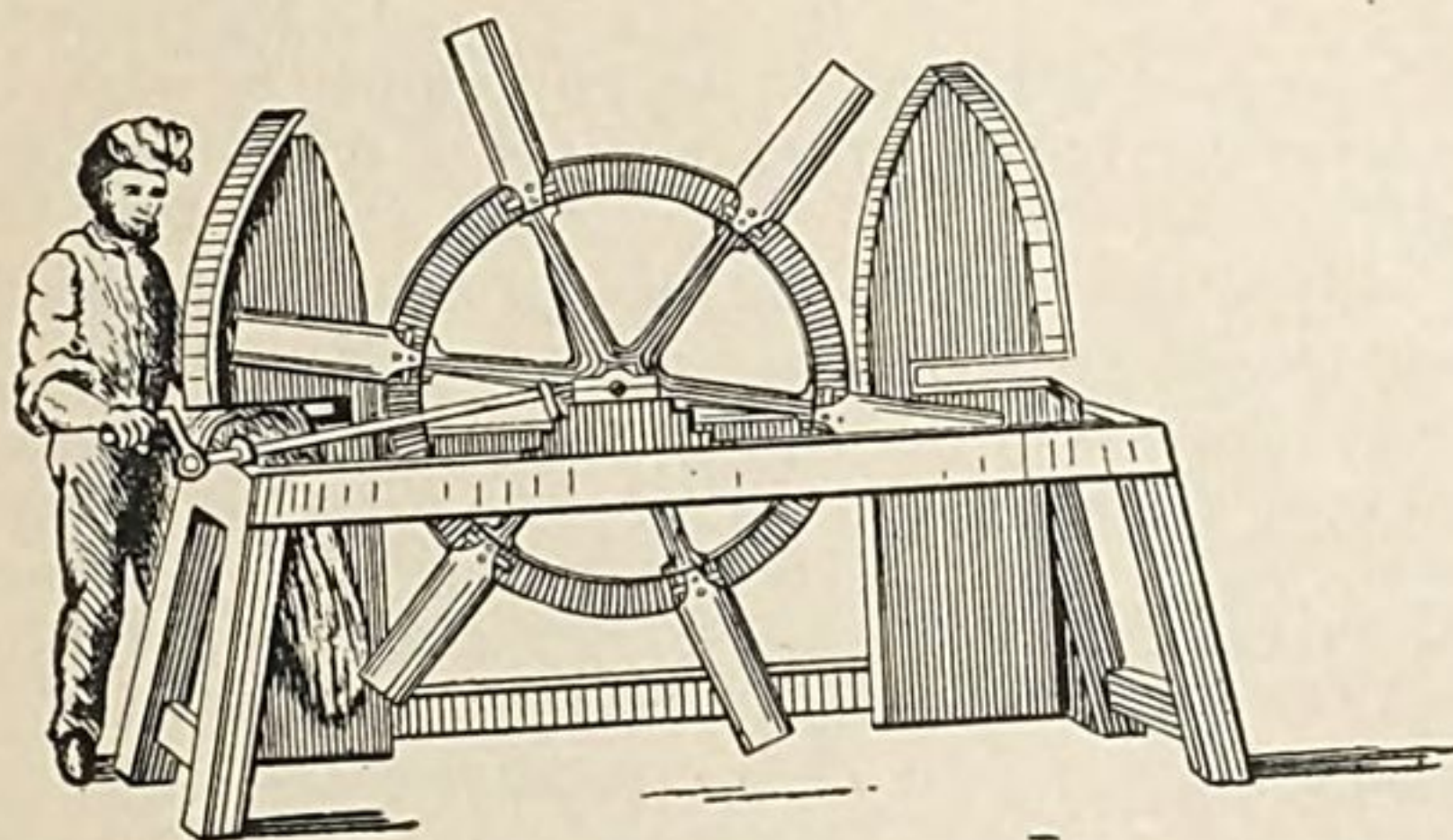


FIG. 2.—Hand hemp-scutching machine.

Mans I saw the operation, which, however, need not be described here, as it belongs to the manufacturing side of the industry, and in the present report we are considering only the agricultural.

Before leaving the subject of retting I should have stated the practice adopted in Lombardy, which it is claimed has given good results. It is described as follows:

A kind of pond or retting tank is constructed, having a depth of about 1 metre and a capacity for holding double the quantity of hemp which is placed in it, to give sufficient space for fermentation. The bottom of the tank is paved, and the sides covered with a wall of masonry to prevent the water from becoming muddy by mixing with the soil as this gives a bad color to the fiber. The tank must be perfectly cleaned after each operation. The bundles of stems are placed side by side under the water and covered transversely with planks held down by heavy stones. The duration of the retting varies according to the height of the temperature, but there have not been up to the present time any precise directions collated upon this point. If this process is too prolonged the fiber loses in weight; if too brief, it is difficult to work.

The cost of producing an acre of hemp in France is stated to amount to \$60, and the farmer's net profit is about 47 francs, or less than \$10, which, after all, is better than the average for wheat production in the United States.

At Le Mans I visited the immense spinning establishment of Janvier, père et fils, et Cie., where many interesting details in the preparation for and final manufacture of the fiber into "linen" and other fabrics were witnessed. In an interesting pamphlet published some 25 years ago by N. Bary, jr., the former proprietor of the spinning mills, now controlled by the Messrs. Janvier & Co., the necessity for an improved process of retting, to do away with the contamination of streams, is dilated upon at length. From the interesting statements made I was anxious to know if the suggestions and investigations proposed at that time had been productive of noteworthy results. I addressed a letter to Mr. Janvier, sr., and in due time received the following reply, which is worthy to be produced entire:

LE MANS, *January 4, 1890.*

SIR: We have your esteemed letter of the 11th ultimo, by which you ask of us some details on the subject of the present processes of retting compared with those of former times.

With pleasure we hasten to answer you, though stating with regret that no progress has been realized in the method of retting hemp. Notwithstanding the numerous researches which have been made, notwithstanding the very great number of tests which have been applied, retting is still done everywhere in the same way. The stalks of hemp, tied by handfuls, are immersed in water and remain there from four to ten days, according as it is running or stagnant and according to the temperature. The inconveniences pointed out in the pamphlet which you have, and which was published in 1886 by Mr. Bary, continue to-day.

One engineer, Mr. Parsy, has, it is true, found a process of retting which has been applied to flax in the works of Mr. Ugache, of Perenchies, near Lille. The material is introduced upon a *wagonet* in a "*batche*" or tank, forming a steaming pan (autoclave) and left for half an hour in contact with the water under pressure of 125°. This water coming from a preceding operation is charged with the oil and some pectic products of the flax and an addition of only one-third of clean water to compensate the loss produced by evaporation. The flax on being taken from the tank is then submitted to a mechanical drying, a process of the same engineer.

We do not know whether this method is still in use at Perenchies; in any case, we think we can affirm that it has never been applied to hemp. This is all the information possible for us to give you.

Entirely at your service, we present to you, Monsieur, our best compliments.

JANVIER, PÈRE ET FILS.

Mr. CHARLES RICHARDS DODGE,
Special Agent U. S. Department of Agriculture,
Washington, D. C.

THE FLAX INDUSTRY IN BELGIUM.

I found considerable diversity in the culture and handling of flax in different sections of Belgium. The best flax, as has been stated in earlier pages of this report, comes from the region of country through which flows the Lys, known as Occidental Flanders. A darker flax is produced in the Waes country, where the retting is carried on in specially prepared retting pools, the water of course being stagnant. In the Brabant, at least in the sections visited by

me, within an hour's ride by railway from Brussels, a still darker flax is produced by dew retting, as in this country, and referred to on a preceding page. This is the poorest flax of all, and as it comes into direct competition with the Russian, which can be sold in the country at a price somewhat less than the native can be produced, the industry is naturally declining.

As to culture, the variation in methods in the different sections refers after all to mere differences in matters of detail. The same careful soil preparation, the systematic rotation, the generous use of fertilizers, careful seeding and weeding, and a careful pulling and harvesting of the crop, are found in Belgium as in France, and for that matter in all countries where fine flax is grown. It will not be necessary, therefore, to waste time and space in going over the entire subject of cultivation again, though it may be well to note special practices which are peculiar to the Belgian flax farmer.

In the first place the Belgian farmer emphasizes the importance of thorough soil preparation by turning considerable of the soil in which the flax is to be grown with the spade, the earth being reduced to the fineness and smoothness of garden soil. There are two positive requisites in this matter, depth and a high state of tilth. In the matter of fertilizers 300 to 400 kilogrammes of chemical manures are applied per hectare before sowing time—spread over the ground—and solutions of night soil poured over it. This is kept in immense reservoirs, and often oil cake is broken into it to make it stronger in elements of plant nutrition. Those who employ stable manures apply them before winter, and oftentimes in connection with some 600 to 800 kilogrammes of chemical fertilizers. The seeding (broadcast sowing) is performed by professional sowers who are paid by the area seeded. Riga seed is almost invariably used. Speaking of Riga seed, an interesting statement was made to me by Professor Damseau, director of the state agricultural experiment station at Gembloux. In the Brabant the seed is not always renewed every year. For example, Riga seed will be planted the first year, the Belgian seed produced from this will be sown the second year, when fresh Riga seed will be again sown in the third year, and so on. A noteworthy point is that the fiber from the second year's sowing, in the Brabant, is considered better than the first. This is not the case, however, in the Courtrai district.

A word upon the subject of rotation in Belgium. Beyond the mere statement that flax is grown on the same soil but once in 8 years on an average, and that grain crops, turnips, potatoes, and clover are most commonly named as favorite crops after which to sow flax, no special order or list of crops can be given, because there is such variation, not only in different sections, but in parts of the same section, or even on contiguous farms. Here are a few state-

ments of favorite orders or rotation in the several flax-growing districts.

Western Flanders.—(1) Oats manured; (2) flax and roots; (3) wheat manured; (4) rye or rape, alone, or with clover; (5) clover; (6) wheat; (7) potatoes or kidney beans; (8) oats with clover and sometimes with wheat.

Eastern Flanders.—(1) Potatoes, hemp, barley, or rye; (2) after potatoes or hemp, rye or wheat; (3) after rye or wheat, flax and clover or flax and carrots; (4) clover, and if carrots have been sown, rye; (5) after oats, after clover, barley or rye; (6) buckwheat or rye. (This rotation is followed in some of the cantons of Alost when flax follows hemp.)

Hainault.—(1) Wheat and clover; (2) clover; (3) flax; (4) after dressing, barley; without dressing, wheat; (5) after barley, rye and clover; (7) wheat; (8) kidney beans or oats; (9) potatoes. (The soil is manured but once during the rotation, but ashes or calcareous compost are spread after clover.)

Brabant.—(1) Oats; (2) flax with “minette”; after the cutting strongly manured with cow dung; (3) wheat; (4) rye and clover; (5) clover dressed; (6) wheat.

Antwerp.—(This rotation is rarely followed.) (1) Flax with clover or with roots; (2) clover; (3) wheat or rye; (4) roots; (5) rye, but with high manuring previously, and carrots; (6) potatoes or oats; (7) potatoes after oats; (8) rye with clover or carrots; or if it were sown singly, roots are put in afterward; (9) oats with clover; (10) clover; (11) winter barley; (12) rye; (13) rape; (14) rye. (The soil is highly manured after each crop.)

Notwithstanding the rollings previously given, a last rolling is effected just before the flax plants appear above the surface that the ground may be firm and smooth at the time of weeding. The weeding is done by women in the same manner as described on another page. When the stalk begins to turn yellow and before the flax is fully ripe it is pulled.

In the Courtrai district this work is rarely performed by farmers, but by the flax merchants who purchase the crop standing and attend to the harvesting, and often to the subsequent operations of retting (in the Lys, as has already been described), and to the scutching or cleaning of the flax as well. Some buyers, however, are simple dealers who purchase of the farmers, attend to the retting, and dispose of the straw at once to some neighboring scutcher.

I visited one of these scutch mills in the little village of Waverleyhem, where the operations of breaking, scutching, and cleaning were in progress. Here the flax was to be seen in all stages of manipulation, from the fully retted whitish-yellow straw to the “streaks” of superbly colored creamy fiber which characterizes the product of this region, as well as the region of France which lies just over the border, and watered by the river Lys or its tributaries. But it

sometimes occurs that a farmer chooses to pull his own flax and haul it to the Lys, where it meets with ready sale at the market price which rules at the time.

While appreciating the fact that the flax retting industry as carried on in Courtrai (and for 20 miles along the Lys) was very large, I was not prepared to see the immense quantities of flax straw which occupy an extended area of the lands contiguous to the river, on both sides, above the town. It is grown in the neighborhood; in adjoining districts; is brought from distant points by four-horse wagon loads; it comes by rail in trains of a dozen to a score of cars. It is even shipped, as I was informed, from the adjacent countries of France and Holland, until the landscape for miles is yellow with it, the river filled with the stone-weighted "*ballons*," and the air redolent with the disgusting odors of the *rouissage*, as the waters take on almost the tint of crude petroleum, and in their sluggish flow seem almost as thick as this substance. Yet at Courtrai the women wash their clothes in it, and the clothes, and the retted flax, come out clean and bright. Truly there is something in the Lys waters that verges on the marvelous.

In the Waes country a form of retting is practiced which is peculiar to the locality, and may be described briefly. I regret that I can not give full credit to the author of a ten or twelve page manuscript in Flemish, which was placed in my hands as I was leaving Brussels, by Mr. Paul du Vuyst (of the Belgian department of agriculture), in which the description occurs. No name or signature appears, upon it, but the brief account of Belgian flax culture it details is so complete that I regret limited space precludes publishing it entire:

The flax having been pulled is immediately rippled.* After this the seed vessels are dried, thrashed, and cleaned, so that the seed may be fed to the cattle or sold to those who press out the oil. After the flax has been rippled it is bound into small bundles, which should be neither too light nor too loose, so that they may be thoroughly penetrated by the water, since the flax is then placed in pits containing water which have been dug for that purpose. With a view of keeping the flax under water, that it may be well retted, it is first covered with a layer of straw upon which sods or stones or heavy boards are placed.

It is impossible to say how long the flax should remain in the water. It is usually left there from 5 to 10 days. The quality of the flax straw, the water, the weather, and other circumstances must be taken into the account in determining the time during which it is allowed to ret. Our farmers know by experience that their flax must be taken out of the water, or, as they commonly say, must be washed out when the straw-like portion of the stalk begins to rot and can be broken. When the flax has been washed out it is immediately spread, while still wet, in the meadows to dry. The time that it must be allowed to lie in the meadow likewise depends upon the quality of the flax, the weather, etc. By cracking a few stalks, or by rubbing them between the hands, our farmers know when the flax is in proper condition to be stored.

*I omit the description of the appliance for stripping the seed, as it is given, practically, in the chapter of the French practice on page 498.

In the Waes country there are two forms of pools for retting flax, which Mr. Renouard calls the "blue" and the "yellow." The blue is the most common, and takes its name from the mud or slime which covers the bottom of the pool. Sometimes alder branches, with their leaves, are thrown into the pools with the flax to add to the blue color or to correct a defective coloration. Sometimes the practice is carried to such an extreme that the fiber produced is of a dark slate color. The pools are used year after year.

Formerly the farmers in this section retted and even scutched their flax, selling their fiber to the dealers. Now, as in the Courtrai district, the division of labor has taken this work out of the farmers' hands and for the most part the flax is sold green.

I have indicated the two principal methods of retting practiced in Belgium. The third, meadow or dew-retting, pertains to the Brabant, to which reference has already been made, and produces the lowest grade of flax.

The comparative loss by the three forms of retting practiced in Belgium, as stated to me by Professor Damseau, is as follows: By retting in the Lys (in running water) the loss is 25 to 33 per cent. In pool retting the loss is a little less, while in dew retting the loss amounts to about 18 per cent. The Lys flax is more solid than other kinds, whiter, and more readily colored in dyeing; and in manufacture produces more fiber and less waste, and the fiber is more lustrous. The proportion of flax retted by the three systems is approximately as follows:

	Hectares.
In the Lys.....	15,000 to 20,000
In pools.....	20,000
Dew-retted.....	12,000 to 15,000

It may interest some of our labor organizations to know that men working in the flax mills of the Brabant receives $2\frac{1}{2}$ francs, or 50 cents in American money, for a day's work, which means from 5 o'clock a. m. to 7 o'clock p. m., with the usual "nooning." A woman in the flax fields receives about half these wages, sometimes 30 cents, and a boy 16 to 20 cents. The best of the Belgian flax, and indeed the larger part of the production is absorbed by British spinners.

As to the methods of rippling the flax in Belgium, that is, the manner of securing the seed, they are for the most part primitive. The long wooden contrivance upon which two men sit astride, and whip out the seed vessels upon a coarse iron comb set up between them, and which has already been described, seems to be more or less common in all sections. Around Courtrai a common practice seems to be to beat out the seed with a small block of wood, either flat or corrugated on the under side, and manipulated by means of a long curved handle. The straw is laid upon the barn floor, or the ground, or even on the stone pavement leading to the door of the peasant's

cottage, and the seed slowly and laboriously mauled out of it. In a large scutch-mill at Gembloux I noticed for the first time in this country the use of a machine for separating the seed. This was provided with large rollers, some 8 or 10 inches in diameter, free at one end, so that the flax heads only were passed through as the bundle of flax was presented by the attendant. After two or three times passing through the workman gave the heads of flax a sharp blow upon the ends of the rollers to shake out any seed remaining, when the bundle was put to one side.

Another method of securing the seed is to run a heavy roller over the flax heads, the straw having been laid upon a slatted floor, the seed falling through as the bolls were crushed.

THE LEFEBURE PROCESS WITHOUT RETTING.

In the Belgian agricultural exhibit at the Exposition, on Quai d'Orsay, there was a collection of flax fiber, in color as light as the Courtrai flax, but prepared by a secret process, the invention of Julien J. Lefebure, of Brussels. As to the details of the invention nothing could be learned, but it was ascertained that the process was intended to clean fiber of flax and other textile plants in a dry state, immediately after harvesting the crop, thus avoiding the expense and the labor of retting. The inventor claims that by this process, which occupies but a few hours, flax can be prepared in any climate and at all seasons of the year, producing a better quality of fiber, and a larger percentage of fiber to straw than by the systems now in vogue. And further claims are made that flax prepared by this process spins easily in cold water into all numbers, and that in processes of manufacture there is a large saving from the ordinary waste. No technical examinations were made by me of the samples of flax fiber shown, and no suggestions are put forth as to the value of the process or the validity of the inventor's claim. The matter is presented here as one of the interesting features of the flax industry exhibits in Paris, and is dismissed without further comment, as nothing definite concerning it can be stated.

THE VAN MULLEM AND DE SWARTE SYSTEM OF RETTING.

During my visit to the state agricultural experiment station at Gembloux I learned of a system of artificial retting, in Lys water, in perfected reservoirs, known as "the Van Mullem and De Swarte system." In conversation with Professor Damseau I was informed that there was a current of public opinion against the retting of flax in the Lys, on account of the contamination of its waters, resulting not only in the destruction of fish, but also in the giving off of foul odors from the decomposition of the vast amount of vegetable matter liberated by the action of retting. The gentlemen whose names

appear in connection with the system of artificial river retting under consideration, have been experimenting for a series of years and with certain practical results. I learned that in the proposed system there is a positive economy, amounting to 10 or 15 per cent., in general improvement of the fiber, quality, etc. The waters of the Lys are purified before being again returned to the river, and the residue from the retting process has a value for manure.

I was also informed that the residents of Courtrai are opposed to the new method, as they wish to keep the industry in the vicinity. Retting by present methods now extends some 20 miles along the Lys but can not well be further extended, as the water becomes very foul. By the new process it is claimed that it can be extended its whole length if necessary. Understanding that there was an exhibit of this reservoir system at the Exposition, I made it my duty, on my return to Paris, to look into the matter, and am therefore able to make a considerable report upon it. The principle of the system is thus laid down by the inventors:

It consists, first, in the employment of water from the natural water courses used just as it is, or simply relieved of its injurious constituents by appropriate treatment; secondly, the employment of water-tight reservoirs, arranged in series in such manner that in each series the reservoirs communicate (1) with each other by near approaches, (2) with conduits for supplying the water, and (3) with conduits for discharging the water. All of the communications are furnished with sluice gates, etc. In each reservoir the communication with the preceding one, and that of the inlet of the water, are at the same extremity (upstream); on the lower side (downstream) are the connections with the succeeding reservoirs and the discharge pipes. In this manner a continuous and regular circulation of water is secured through the bundles of straw or stalks (of hemp or flax) in each reservoir.

The water entering pure into any one of the reservoirs runs through all the others in their order, as determined by the connection between them, the exceptions being those which are detached from the circuit for the purpose of emptying and cleaning them as well as repairing and refilling. Each reservoir in turn receives at first the most impure and surcharged water; then that next to the last, and finally the first, or clean water. In this manner the flax straw receives the purest water when the retting is nearly completed. By this manner two important results are secured: The accelerating of the fermentation of the flax at the beginning, and the retarding at the completion of the retting.

It is claimed that, other conditions being equal, the rapidity of the fermentation augments in proportion to the richness of the liquid used. In the Lys it has been shown that the retting is accomplished most readily when the river contains the largest quantity of flax.

It is also shown that the retting upstream is accomplished less advantageously than that downstream, where exists the greatest "*bouillon*," or "ebullition, or effervescence of retting," which is thought so indispensable to pectic fermentation. But if the water upstream does not give as good results as farther down, owing to a less degree of this "effervescence," it is shown also that the water far downstream becomes likewise unfavorable because of so many fermentations, the result of which is to gradually choke up and hinder the proper fermenting of straw placed in it. It is said that the only locality entirely favorable is above Courtrai where the waters of the Lys have had continuous and extensive circulation among the crates of flax or ballons, and have acquired just the right degree of fermentative action without becoming positively putrid.

The renewal of the water in these *ballons*, in the river retting, is very slow because of their compactness, and the pectic fermentation, under these circumstances, is claimed to be better than it could be in any other system which might be introduced to supplant it.

In view of these facts, the inventors of the artificial system claim that the freshly changed flax is in the most favorable condition for a rapid and regular development of pectic fermentation. The retardation which takes place in the latest period, *i. e.*, when the purest water is let in, causes it to be less uncertain regarding the exact time when the flax should be removed, or to put it the other way (as far as this system is concerned), when the water may be withdrawn altogether, and the flax left to dry. Another point, too, is the avoidance, during the drying process, of the continuation of fermentation which may take place in damp weather. Another point worth noting in this system is the diminution of the quantity of water necessary for retting. The water running from each reservoir is led into the following one, instead of being run off and lost. The same water suffices for a series of reservoirs as for one. The inventors state that in order that the water flowing from one reservoir may be suitable for the flax in the succeeding one, there must be a certain distance between the different reservoirs. A series of eight reservoirs has been adopted, therefore, which gives an average of one day to each reservoir. As the principal object of the system is to suppress the contamination of the river Lys, the water from the sluices must be returned to the stream at some point near the sea, or be purified before it is finally discharged. Naturally, the smaller quantity of water that can be employed, the more readily can the purification be effected. This, then, is the principle of the system of artificial retting in reservoirs.

The first experiments were conducted near Harlebeke in 1887. Since then, however, the eight reservoirs and the supplemental decanting and collecting reservoirs have been rebuilt, to avoid certain imperfections in the original construction, which I need not

refer to here. Regarding the decanting reservoir, from the fact that the Lys water contains, besides the heavy matters which exist in it, a large quantity of dark or turbid material, floating sometimes on the surface and sometimes at various depths, it became necessary to supply filtering material to each reservoir, and eventually to establish a filtering reservoir after the decanting reservoir. By this means the water is received perfectly free from turbid matter, which has a great influence upon the color of the flax.

The results of the early experiments were most favorable, proving that the reservoir-retted flax was invariably equal or superior in quality to the same flax retted in the Lys by old methods, while the yield of fiber is invariably superior. To state it differently, in the reservoirs the flax loses less weight from the process of retting, and an equal number of pounds of flax in the straw, after the retting, contains more fiber when broken. Regarding the advantages of the system on the score of public utility, were it generally adopted, there are several points for consideration.

(1) In relation to animal life in the river, the statement is made that while formerly the Lys contained a greater abundance of fish than any other stream in the region, at present there does not exist, in the retting season, a single fish between the towns of Warneton and Deyuze. And almost the same may be said of the waters between Deyuze and Gand, or in the canal from Gand to Ostend. On the contrary the upper Lys is still well stocked with fish, and in the winter when the effects of the contamination have passed away the fish spread through the entire course of the river. For the propagation of fish, that may be available for food at all seasons, it is extremely desirable that the contamination of the Lys waters should be abandoned.

(2) In relation to the general healthfulness of the sections through which the Lys flows, an effort is made to show that, first, by the absence of fish, putrid animal matters floating in the waters are allowed to accumulate to a degree detrimental to health, and secondly, that the quantities of fish themselves, killed in the early part of summer, form a mass of decomposing matter which must augment the injurious effects of the preceding. It should be noted here that the decomposition of the waste matter from the flax straw in process of retting is not considered injurious to public health, nor do those who are constantly at work along the river, where the odors from decomposition are the strongest, suffer in any way from them. On the contrary, I was informed, when at Courtrai, that in years of fatal epidemics the flax-retting region of the Lys Valley has usually escaped, or the epidemic has appeared in a mild form.

(3) In relation to the feeding of the canals of Gand, which are supplied by the river Lys. This refers to the yearly change in the waters of the Gand by the substitution of the Escaut, the supply of

which is, at times, insufficient, the lowering of the waters proving a serious inconvenience. This is a matter, however, of local interest, and need not be pursued further on these pages.

Other points are considered, among them navigation of the Lys, the two lines of flax *ballons* on either side of the stream now preventing the passing of vessels; also the establishment of other industries along the banks of the stream, which would use the Lys waters in their operation, etc.

In conclusion, the inventors claim that the adoption of this system would prove additionally advantageous by increasing the culture of native flax and hemp as well; by returning to the soil of Belgium millions of kilogrammes of valuable fertilizers that under present conditions are annually allowed to be carried out to the sea in the most dangerous form possible; by preventing all accidents and risks that occur from the operations of retting in the open waters; by producing a perfectly uniform flax; by increasing the yield obtained; by improving and facilitating the labor of the workmen; and finally, by producing the maximum development of the industry of retting in the Lys Valley and overcoming all obstacles to a full development, while reducing accidents and injuries to about one-third of those existing at the present time.

THE RAMIE MACHINE TRIALS OF 1889.

In behalf of the American Commission to the Paris Exposition, and also under instructions from the United States Department of Agriculture, I attended, in September, the trials of the several ramie decorticating machines that had been entered for competition. Six machines and one process were entered, as follows:

P. A. Favier, representing the "Société la Ramie Française," 14 rue Saint Fiacre, Paris: Two machines; one for working green stalks, and one larger machine for dry decortication.

E. Armand and Paul Barbier, 46 Boulevard Richard-Lenoir, Paris: A machine for dry and green decortication.

Felicien Michotte, 43 rue de Saintonge, Paris: A machine for both dry and green decortication.

Norbert De Landtsheer, 2 Place des Batignolles, Paris: Two machines, large and small, for both steam power and hand use.

Ch. Crozat de Fleury and A. Moriceau, Villiers-le-Bel, Seine-et-Oise: A process for treating ramie stalks without the aid of machinery.

Previous to the trials I had examined as far as possible the machines of the four mechanical systems represented above, and had the satisfaction of seeing them work on stalks from several localities, including some from our own country, which were grown in Texas in the year 1888. From the working of these machines, therefore, both on green and dry stalks, I obtained a fair idea of what they were able to do as far as *quality* of ribbons was concerned, the questions of *quantity*, and ability for *continuous operation* remaining for the official trials to determine. The first official trial was with the smaller machine of

THE FAVIER SYSTEM.

I give herewith a description of this machine in Mr. Favier's words:

It is composed of a framework, about 3.50 metres* in length and 0.75 metres in width, upon which, for about the length of a metre, rests the first part of the machine, the peeler or stripper, and in line with this is the second part, or rubber and scraper. Although the machine can be divided into two distinct parts, that which is described is one continuous apparatus. The stripper is composed of two pairs of vertical rollers placed in front of the machine, which corresponds to two

* A metre is 39.37 inches; or about $3\frac{1}{8}$ inches over a yard.

openings. These rollers serve the purpose of seizing the stalks which are placed upon them, and which they introduce automatically into a mechanism which may be called the mouth or jaws. The arrangement of this device is extremely simple, is based upon what we declare to be indispensable, that of the longitudinal slitting of the stalks of the ramie, thus laying them open, and laying bare the interior wood. We effect the application of this principle, which constitutes the most important

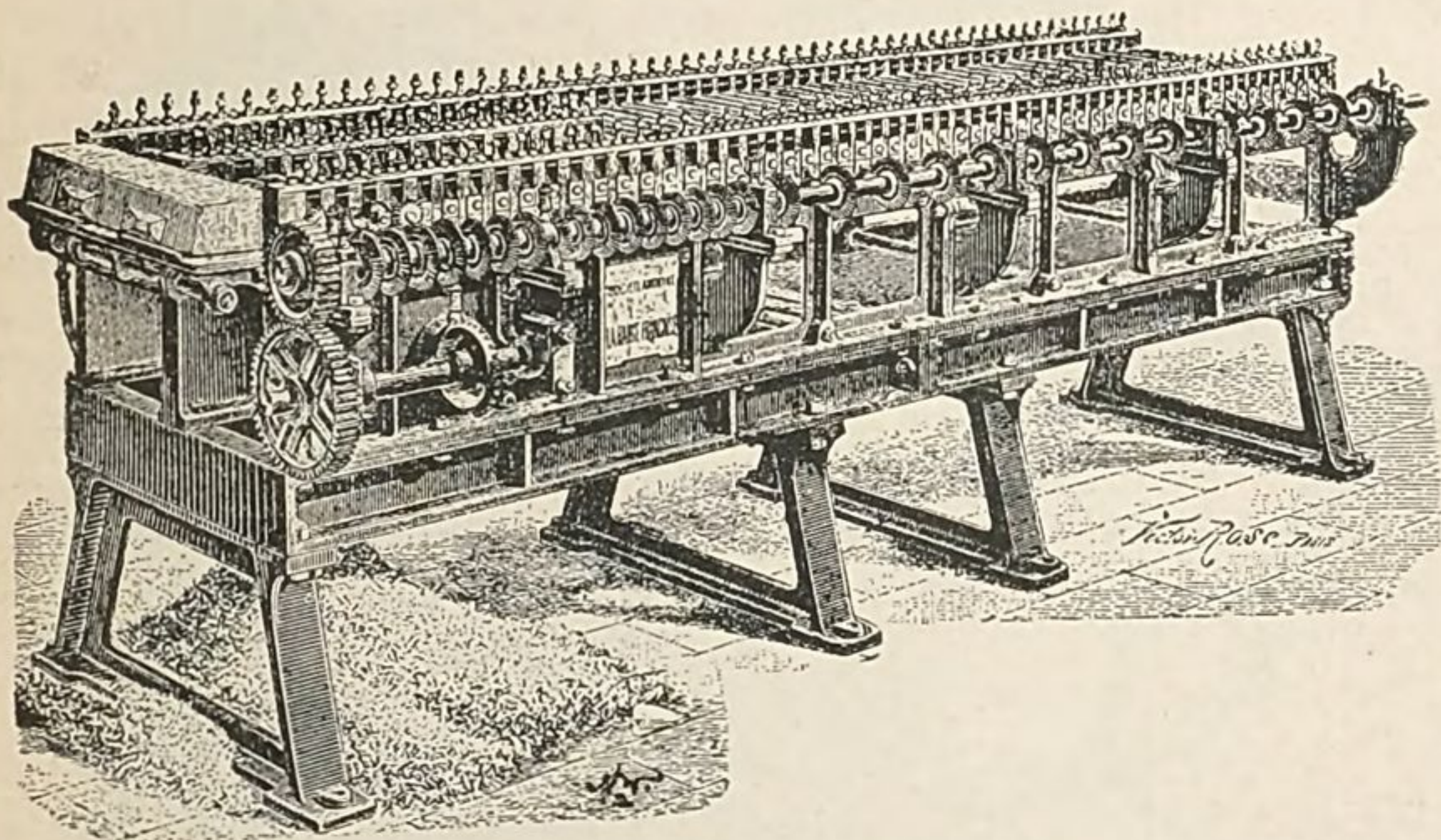


FIG. 3.—The Favier ramie machine.

part of the invention, by placing in this “mouth” a knife for the purpose of splitting the stalks their entire length. As soon as the stem is split, the interior conformation of this mouth-like device spreads it open so that it forms a ribbon presenting the wood upon one surface and the bark on the other. Following, there are several pairs of smooth cylinders, designed for rolling and flattening the stalk and effecting the thorough detachment of the bark from the wood by the crushing of the resinous matter which holds them together, thus forming two ribbons, one upon the other, one being composed of wood and the other of bark, but entirely detached. Then follows a series of cylindrical breakers having large grooves for the purpose of breaking the wood into small fragments, which then fall under the machine. This is the machine for stripping. That for scraping is still more simple, composed of a series of cylinders with small grooves of such extent and gradation as is required by the disintegration desired.

One of the French experts, in speaking of the machines of this system, states that in the one for green decortication there are eight series of mechanisms and forty-two shafts, and in the dry decorticating machine seventeen mechanisms and eighty-seven shafts.

The smaller machine of the two, which is 2 metres long and 0.80 metre broad, and weighs 800 kilogrammes (or 1,760 pounds), was used in the first trial. In this trial there were 10 kilogrammes (22 pounds) of stripped stalks operated upon, which were decorticated in 4 minutes and 30 seconds, including slight stoppages. The ribbons produced, wet, weighed 2.82 kilogrammes (about 6¼ pounds), and they were well cleaned. In the second test 60 kilogrammes of unstripped stalks (123 pounds) were operated upon, these being divided

into two lots of 10 and 50 kilogrammes, respectively. The times for both lots were $2\frac{1}{2}$ and $15\frac{1}{2}$ minutes, the proportionate difference in time being due to the fact that the last pair of rollers became clogged with loose ribbons in working the second lot. The product was 18.1 kilogrammes of wet ribbons.

The test on dry ramie was made on the 24th of September, the day following the green tests, with this result: 30 kilogrammes of dry stalks were decorticated in 33 minutes, yielding 7.70 kilogrammes of very nice ribbons, or very nearly 17 pounds, from 66 pounds of dry stalks. Deducting stoppages, of which there were several, the actual time was 27 minutes and 40 seconds. Two men attended the machine at these tests, although the full complement of attendants is four, which would give almost double the quantity of prepared fiber. The dry *filasse* produced by the Favier machine is very fine and soft, and is more perfectly cleaned than that from the other machines, the larger portion being in fit condition for spinning into the coarser manufactures.

From the complicated nature of the mechanism of this decorticator it could never be employed for field work, but would of necessity be used in the factory system of decortication. It is also a costly machine, the price of the larger or decorticator for dry stalks being placed at 5,000 francs, and the smaller or green stripper at 2,500 francs. Either machine is run by a force of three-quarter horsepower. The refuse of decortication, in the form of very fine pieces of wood or chips, is used for fuel to feed the boilers, although one machine will produce fourfold the quantity required for the purpose.

Regarding the attendants, Mr. Favier states that two women and two children will do the work quite as well as four men. In the machines of this system the complicated mechanism is protected by sheets of iron, which close them in like the cover of a box, which also serve to keep out dust and débris. Returning to the account of the first day's trials, the next machine visited by the officials was

THE ARMAND-BARBIER DECORTICATOR.

This machine is so similar in principle, construction, and form to the Landtsheer machine, described further on, that no description is necessary, save to state that the stalk is stripped by being twice fed into the machine. That is, after being run more than half way through, the hip of the operator presses a lever, the motion is reversed, and the stalks withdrawn, to be turned and fed in again, this time running through the machine. Necessarily, this entails a considerable loss of time. The ribbons were not well cleaned, and there was likewise some waste fiber, which found its way to the pile of refuse under the machine. The first trial, with 10 kilogrammes of stripped green stalks, resulted in a product of 1.30 kilogrammes of

wet ribbons in 6 minutes, or 2.8 pounds of ribbons from 22 pounds of stalks. In the second trial 24 kilogrammes (5.28 pounds) of stalks with leaves were operated upon, the time required being 10 minutes and 30 seconds, producing 1.20 kilogrammes ribbons. The trial with dry stalks on the following day gave 2.20 kilogrammes of indiffer-

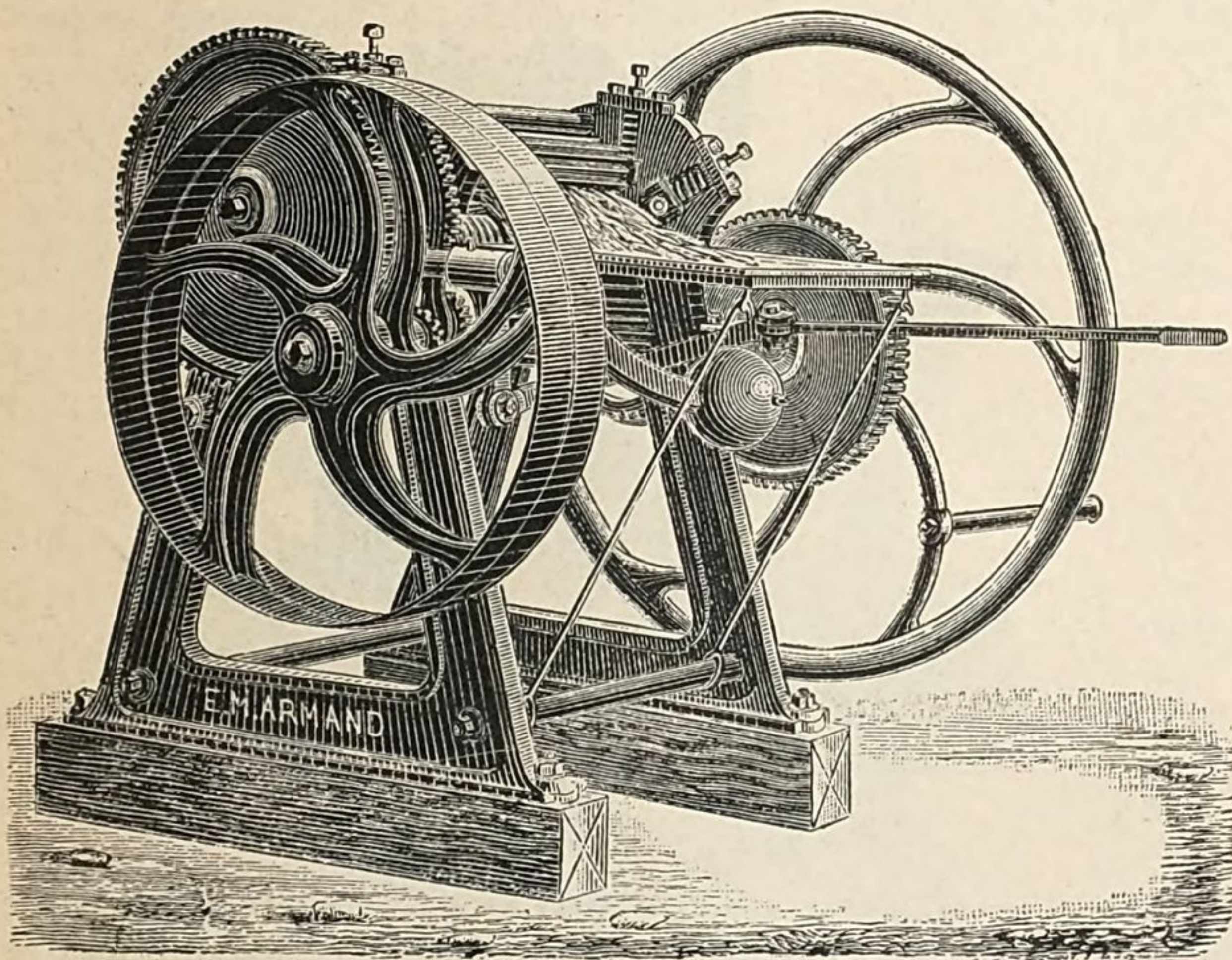


FIG. 4.—The Armand-Barbier machine.

ent ribbons in 30 minutes from 12 kilogrammes of stalks, or $4\frac{1}{2}$ pounds from $26\frac{2}{3}$ pounds stalks. The machine is quite simple, requires small floor space, and costs 1,200 francs. It weighs about 1,400 pounds. The next trials to record are those with

THE MICHOTTE MACHINE.

In this piece of mechanism the aim of the inventor has been to increase the capacity and give a larger quantity of fiber in a given time than other machines have been capable of producing. To this extent it may be said that the inventor is working in the right direction, for the fault of ramie machines generally, both in Europe and America, has been that they do not produce the quantity to make them practical for actual field work; but with this machine, whatever improvement may have been made in this particular direction, there is the more serious fault of turning out a quality of product that is very poor, from the ribbons being injured and broken in the process of decortication. The ribbons decorticated for me at a pri-

vate working were much better than the wet ribbons produced at the trial, proving, as is frequently the case, that fairly good work may be done with a machine on a small scale when it will not stand the demands of a practical test at full working capacity for a given time. The dry ribbons are broad and flat, none of the outer pellicle

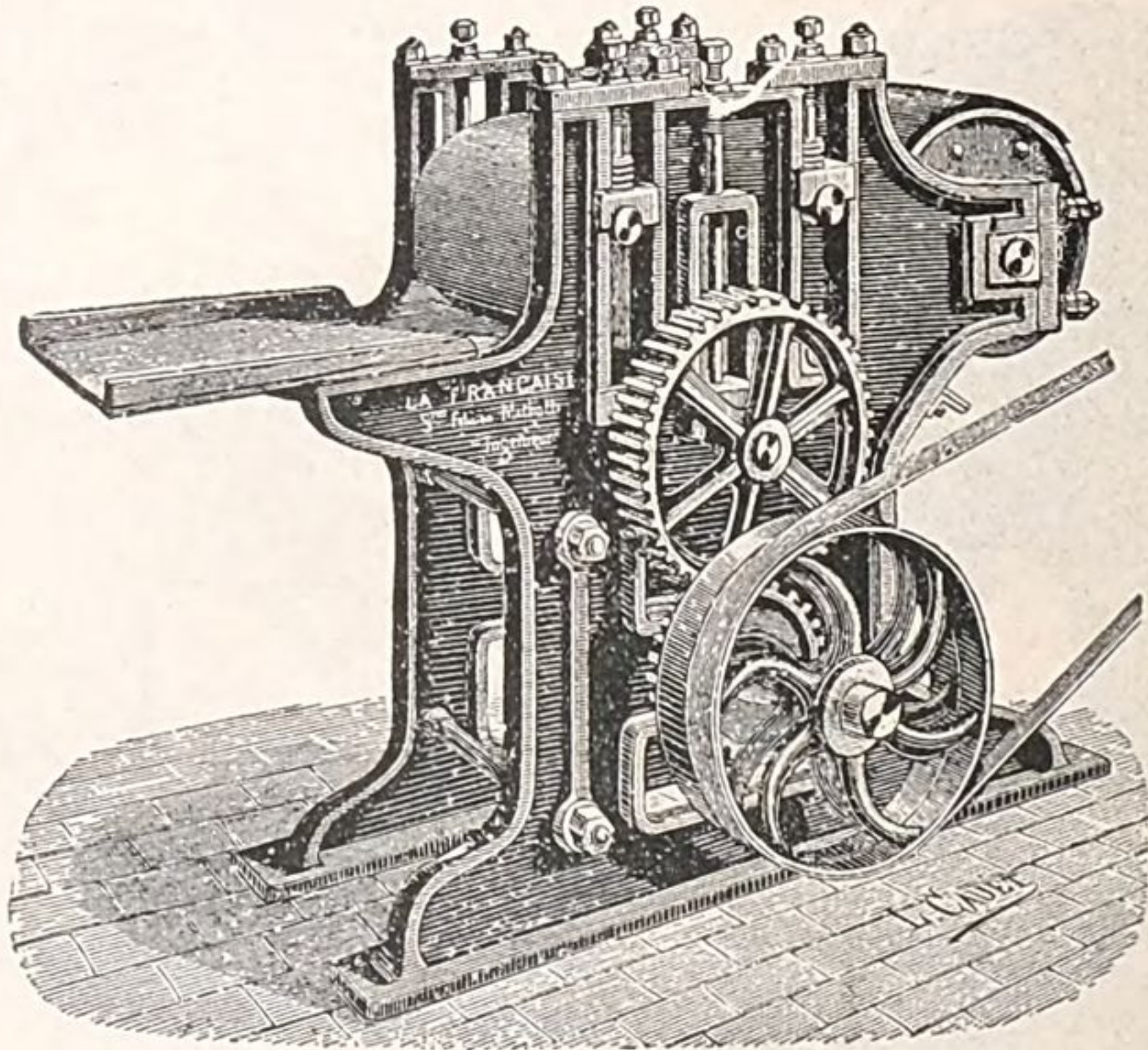


FIG. 5.—The Michotte machine.

being removed, and the woody matter or waste is detached in large pieces. I have not a description of this machine, though it may be described in a few words as consisting of “a pair of large rollers, each furnished with helicoidal grooves running their whole length. The large rollers first crush the stems and then pass them on to beaters with movable bars intended to get rid of the wood and pith.” Here is the record of the trials which were made with green stalks:

First trial: 7 kilogrammes without leaves ($15\frac{2}{5}$ pounds) in 1 minute 30 seconds, the product weighing 1 kilogramme or $2\frac{1}{5}$ pounds, the ribbons not being well cleaned and containing some quite large pieces of chips. In the second trial 17.4 kilogrammes of stalks with leaves were operated upon in $2\frac{1}{2}$ minutes, the product weighing 6 kilogrammes, or about 13 pounds, of wet ribbons from 38 pounds of stalks.

THE LANDTSHEER MACHINES.

I endeavored to obtain from the inventor a description of these machines, but did not do so. The working of the larger one, however, may be explained as follows:

It is composed of three cylinders tangent to another central cylinder. The feeding cylinder is arranged with spiral grooves to regulate the feeding of the stalks. The crushing-cylinders are alter-

nately smooth and grooved longitudinally in such manner that, when working together, the grooved part of one bearing upon the smooth parts of the other crushes the stalks. These cylinders are held in place by springs. After leaving the crushing cylinders the broken stalk passes between a pair of beaters, each supplied with sixteen winglets, geared in such manner that they lightly interlock, this

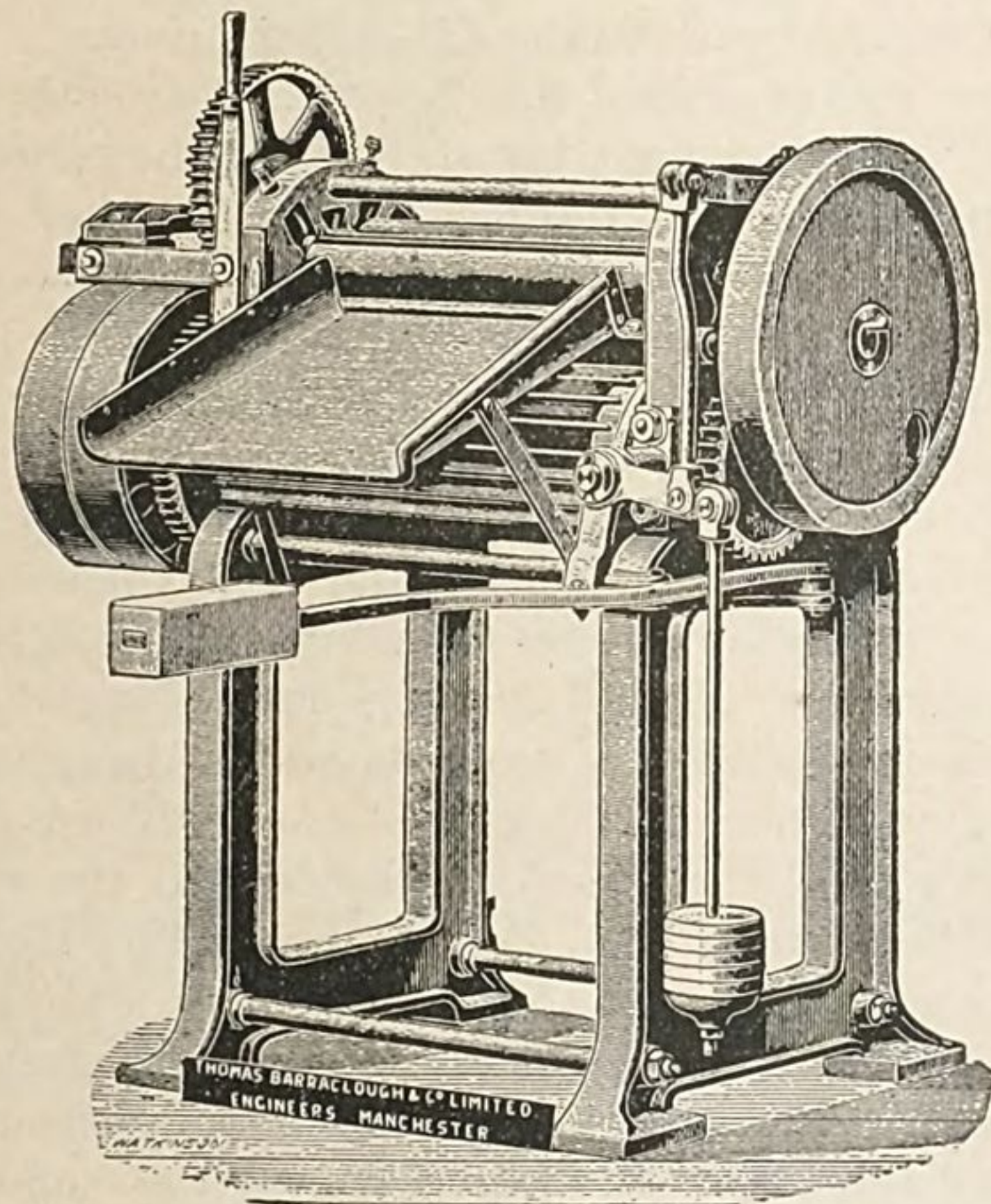


FIG. 6.—The Landtsheer decorticator.

action brushing off or removing the woody matter and the bark. The machine exhibited at the official trials of 1888 was constructed with the reverse action which was referred to in describing the working of the Armand-Barbier decorticator on another page. In the trials of 1889 in Paris, an improvement in the larger machine on the machine used in 1888 was noted, inasmuch as the stalks were run through without withdrawing. In the smaller machine, however, the reverse action is retained. Both machines are exceedingly simple, though the larger machine choked badly when an attempt was made to insert a few more stalks than its capacity, and there were several other stoppages.

In one of the trials where the stalks were fed tops first the last 4 or 5 inches of the stalks were not well cleaned, pieces of almost unbroken wood an inch or more in length remained loosely adhering to the ribbons. When fed large ends first better results were obtained, though none of the ribbons were free from chips and woody matter. The trials with the Landtsheer machines gave the following results:

First trial: 36 kilogrammes (79.2 pounds) of stripped green stalks gave in 2.35 minutes 10 kilogrammes (22 pounds) of wet ribbons. These stalks were run through in two lots, there being 10 kilogrammes without leaves and 26 kilogrammes with leaves. The next test was with 46 kilogrammes of green stalks with leaves, there being 200 stalks in the bundle, as I was informed, though I did not count them. The decortication was accomplished in 11.30 minutes, and the product of wet ribbons weighed 15 kilogrammes. After weighing these ribbons were passed through the smaller machine in 6.30 minutes, reducing the weight through the removal of loose woody matter or chips to 10.5 kilogrammes, a shrinkage of exactly 30 per cent.

If this particular trial demonstrated anything, it proved that it required 18 minutes to decorticate and clean 101.2 pounds of ramie stalks with leaves, giving a product of 25.1 pounds of fiber. Counting the time as for one machine this is equivalent to 3,369.96 pounds of stalks in a day of 10 hours, producing 769.23 pounds of wet ribbons. An acre of ramie stalks, with leaves, 6 feet high, in India, weighs 48,000 pounds. Therefore at the rate of speed shown in this trial, one machine with two operations would decorticate and clean an acre of ramie stalks in 14.27 days, almost half a month; and with 50 acres of ramie, if the ramie would keep until the work was completed, it would require $713\frac{1}{2}$ days to finish the decortication, or, counting 300 working days to the year, 2 years, 4 months, $13\frac{1}{2}$ days.

In another trial with the small machine 24.4 kilogrammes of green stalks with leaves gave 6.5 kilogrammes of ribbons in 10 minutes. In the trial with dry stalks 30 kilogrammes were operated upon in 21 minutes, giving 10 kilogrammes of flat ribbons with the outer pellicle adhering. Two men were required to attend each machine, and a force of one-half to two horse-power is required.

THE FLEURY-MORICEAU PROCESS.

This is a process in which a quantity of stalks are boiled in a rectangular galvanized iron tank set above a fire space upon masonry. The stalks are submitted to the action of boiling water (or other solution) for a certain time, varying from 5 to 15 minutes, after which they are removed and stripped by hand. In the trial 18 kilogrammes of green stalks were boiled for 10 minutes, the decortication requiring 36 minutes, two persons being occupied all of the time, with occasional outside assistance that was equal to another man for half the time. The product was 5 kilogrammes of clean, nice ribbons. As the process would be too laborious and costly to introduce into the United States, should ramie culture be established, it needs no further consideration in the present report. In the French colonies, or in the British colonies, where labor is cheap, however, it would doubtless give good results, and to that extent the trial in Paris was interesting.

Summary of the trials of ramie machines.

Machine.	Weight of stalks.	Condition of the stalks.	Time.	Weight of fiber.
	<i>Kilos.</i>		<i>' "</i>	<i>Kilos.</i>
Favier, small.....	10	Green without leaves.....	4 30	2.82
Do.....	60	Green with leaves	18	18.1
Favier, large	30	Dry stalks	33	7.70
Armand-Barbier	10	Green without leaves....	6	1.30
Do.....	24	Green with leaves	10 30	1.20
Do.....	12	Dry stalks	30	2.20
Michotte	7	Green without leaves.....	1 30	1
Do.....	17.4	Green with leaves	2 30	6
Landtsheer, large.....	36	Green without leaves...	2 35	10
Do.....	46	Green with leaves	11 30	15
Landtsheer, small		The 15 kilos of ribbons from preceding.....	6 30	10.5
Do.....	24.4	Green with leaves	10	6.5
Landtsheer, large.....	30	Dry stalks	21	10
Fleury-Moriceau process	18	Green without leaves.....	46	5

The following letter received by me explains itself:

LA RAMIE FRANÇAISE, *Paris, September 25, 1889.*

SIR: Yesterday an essay was made of my machine for dry ramie, by two operators, before the competitive jury, and 30 kilogrammes of dry stalks passed through the machine in 33 minutes. This time included several stops, with unimportant rollings up, as a consequence of the wet condition (from rain) of the stalks. The result of this essay confirmed what I previously stated.

For the decortication of green ramie, you know I offered a machine in rather an unperfected condition. You were present at the trial. It was not entirely satisfactory, but after a few changes I asked the jury for a new trial, which was granted, and 10 kilogrammes passed through it in 2½ minutes.

I then asked for the application of a more severe tests, and the jury assembled this morning for the purpose of according it.

With two operators 51 kilogrammes passed in 15 minutes. The decortication was perfect, but there were some trifling rollings up. The result of this must be to place my machine in the first rank. I propose, however, to make a slight change in it, and should you be in Paris in a fortnight, I hope that you will find it in perfect working condition.

I wished to keep you informed of what has passed, that you might, did you deem it proper, recommend the machine to your Government, after the jury should have assured you of its accuracy and perfection.

Will you accept, sir, the assurance of my distinguished consideration.

A. FAVIER,

Director, La Ramie Française.

Mr. CHARLES RICHARDS DODGE,

*American Commission to the Paris Exposition,
27 Avenue de la Bourdonais, Paris.*

In a letter sent me October 27, the result of another trial is reported as follows:

In 12 minutes we have passed through the machine 100 kilogrammes of green stalks which correspond to 500 kilogrammes an hour, or 5,000 for 10 hours, with but two workmen. With four workmen it is not exaggerating to say that we can operate upon 7,500 kilogrammes.

ARTIFICIAL SILK.

While the consideration of the manufacture of artificial silk might be thought out of place in a report upon textile fibers of vegetable origin, inasmuch as this product is derived from cellulose, and in its original form is the fiber of wood or of cotton, we may fairly give it a passing notice in the pages of the present report.

This process, the invention of the Count de Chardonnet, is intended to produce from pure cellulose, as a starting point, an artificial substance resembling as far as possible in form, appearance, and in adaptability to the uses of manufacture, the animal substance spun from the cocoons of *Bombyx mori* (or other species) and known as silk. The exhibit, illustrating the process of drawing out the filmy thread of artificial silk and reeling it into skeins of wonderful brilliancy and finish, was one of the most interesting in Machinery Hall. While the details of the process belong alone to the inventor, enough of the principle has been indicated to answer the question "What is artificial silk?"

The Count de Chardonnet, who was formerly a student in the Polytechnic School, states that various kinds of cellulose can be employed to produce the substance out of which the silk is drawn, on condition that they are pure and not liable to alteration by reagents. In his own experiments he has given his attention principally to cotton and the pulp of soft woods, sulphureted. He says:

With these materials there is formed a pure octonitric cellulose, dissolved in the proportion of 6.5 per 100 in a mixture of 38 parts ether and 42 parts alcohol. This collodion is inclosed in a reservoir of tinned copper where an air-pump keeps a pressure of several atmospheres, which is held down by a ramp, upon which are fixed glass tubes terminating in a capillary section A. A second tube, B, envelops each of the first and receives an excess of water by the tubulure C. This water, held by an India rubber pipe, D, falls again around B. The collodion driven through the orifice A is immediately solidified at the surface in contact with the water, and falls with this water in thread form around B, and there pincers, which move automatically, take up the thread and carry it over the reels, which are turning above. The threads coming from the neighboring jets are united, forming a combined thread like raw silk. Each jet is furnished with a device for regulating the size of the thread. In manufacturing this thread the jets and bobbins are inclosed in a glass case to prevent the loss of the dissolvent, and in which an even quantity of air circulates, being constantly reheated at the entrance of the machine (to dry the threads) and cooled again at the exit (to collect the vapor). The skeins are formed like those from the silk of cocoons.

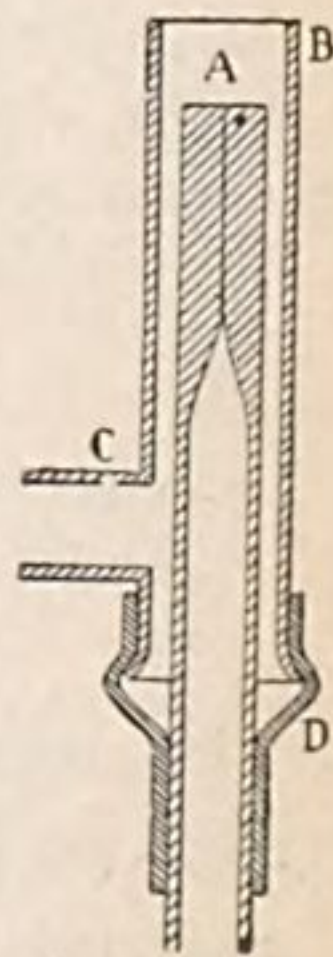


FIG. 7.

Starting with paper pulp, which is pure cellulose, this is nitrated, as has been shown, transforming it into pyroxyline or gun-cotton. It is this collodion that is spun, and the "silk" is naturally inflammable to a high degree, and consequently in this form would be a decidedly undesirable form of fabric to use for any purpose. It is necessary to denitrify the silk, therefore, before the processes of spinning and subsequent manufacture. The various pyroxylines reduced in tepid baths lose their nitric acid. Pure water is also effective, though the reaction is even more complete in diluted nitric acid. The nitric acid of the cellulose is removed by a dissolution which takes place more or less quickly in proportion as the bath is warm and concentrated; but it can be pushed farther in proportion as the bath is cooler and more diluted.

The inventor says :

I employ nitric acid to a density of 1.32, and the temperature should descend slowly from 35° to 25° C. In the end the cellulose becomes gelatinous, easily absorbing various substances by endosmose, notably coloring matters and the salts. The dissolvents of the collodion have no more action, the threads have lost their explosive properties and can be used without danger in most applications, and especially by mixing them with other textiles ; but they can be rendered still less combustible, perhaps, than hemp or cotton by causing them to absorb phosphate of ammonia on being removed from the nitric bath.

The elasticity of the artificial silk is claimed to be equal to the natural silk of animal origin. The elongation before rupture is from 15 to 25 per cent. "The real elasticity is about 4 to 5 per cent." A square millimetre of artificial silk will stand a breaking strain of 25 to 35 kilogrammes. Raw silk will break at 30 to 45 kilogrammes. In density, artificial silk rates at about 1.49, coming between that of natural raw silk at 1.66 and natural boiled silk at (about) 1.43. In luster and brilliancy it is said to surpass the natural article. Examined under the microscope in section, the filament of artificial silk has the appearance of a grooved cylinder.

It is claimed that this silk can be produced for 15 to 20 francs per kilogramme, or about \$1.40 to \$1.80 per pound, natural silk costing from three to four times as much.

In the exhibits of woven fabrics from this product some are shown made wholly from it, others mixed with natural silk or other fibers. A beautiful sample of this silk was given me by Count de Chardonnet, though it had not been denitrified. If this silk is now manufactured in commercial quantity I do not know it. Such was not the case at the time the examination of the exhibit was made. I heard at the time rumors of an American company having been formed to manufacture silk after this process, but have learned nothing definite since in regard to the matter.

REPORT ON CHEMICAL AND PHARMACEUTICAL PRODUCTS.

LETTER OF TRANSMITTAL.

CORNELL UNIVERSITY,
Ithaca, New York, February 12, 1890.

SIR: I have the honor to transmit herewith my report on the Chemical and Pharmaceutical Products exhibited at the Paris Exposition of 1889, and also upon the processes and apparatus by which these products are manufactured. Owing to the variety of the exhibits included under the Fifth Group, and the evident impossibility of covering the whole field in an exhaustive manner, it has seemed to me best to give my chief attention to Class 45, which comprises the most interesting and important exhibits of the group, and in which my service as a member of the jury gave me the opportunity of obtaining accurate and complete information. The other classes assigned to me have been treated more briefly, but an effort has been made to point out the most important advances in each branch of industry, and to include as full notes in regard to the most striking exhibits as could be added without unduly extending the limits of this report.

Very respectfully,

SPENCER B. NEWBURY.

Gen. WILLIAM B. FRANKLIN,
Commissioner-General.

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INTRODUCTION.

The display of chemical and pharmaceutical products at the Exposition of 1889 was in many respects a remarkable one, and included many specimens and models illustrating important discoveries and advances in the field of chemical industry. Nevertheless, the exhibit as a whole must be considered inferior in extent and completeness to that of the Exposition of 1878. The non-participation of Germany, whose manufacturers hold the first rank in the production of the finer chemicals, was, as in 1878, a serious drawback to the interest of the chemical section. England, the home of the great chemical industries, sent but few exhibits, while most of her leading manufacturers whose products added much to the impressiveness of the Manchester Exhibition of 1887, were without representation at Paris. In the United States section many interesting exhibits were to be found, making on the whole a showing creditable to the country. In view, however, of the great development which chemical industries have received in this country during the past 10 years, and the importance which the manufacture of fine pharmaceutical products has assumed on this side of the Atlantic, it is much to be regretted that our leading manufacturers were not so fully represented as to give a just impression of the position of these industries in the United States. It should be remembered, however, that scarcely one of the American exhibitors in this group could have hoped to receive any pecuniary return from his participation in the Exposition, and that the products displayed were in many cases sent from a disinterested desire to do credit to the country. The exhibits of Belgium and Switzerland, though interesting and striking, contained little for which novelty could be claimed. Other countries presented comparatively few exhibits which call for special mention, though the display of drugs and other products of forest industry sent from the French colonies, Asia, Africa, and the East and West Indies, would have well repaid closer study than the time at the disposal of the jury would allow.

On the other hand the exhibit of France was remarkably fine and complete, and included many sets of specimens illustrating important discoveries and improvements in manufacturing processes. The beauty of the products shown, and the remarkably effective manner in which they were arranged and displayed, combined to make the chemical gallery one of the most attractive and striking features of

the Exposition. The English section included also certain exhibits of immense industrial importance, which prove that country to be in no present danger of losing her preëminence in the field of chemical manufactures.

The two most important inventions in industrial chemistry which have lately appeared are, undoubtedly, the Weldon-Pechiney chlorine process (France), and the Chance process of sulphur recovery (England). Both of these were fully illustrated at the Exposition, and each received the grand prize at the hands of the jury, these being the only awards of this grade which were conferred in honor of the discovery of new chemical processes. Through the courtesy of the inventors the writer was enabled to visit the works at which these processes are in operation. Since these discoveries are likely to have some influence upon the industries of this country, their practical significance has been discussed with some fullness in the following pages. The writer would here express his hearty thanks to Prof. Watson Smith and Mr. E. K. Musspratt, of London, Mr. A. M. Chance, of Oldbury, Dr. Readman, of Edinburgh, Mr. A. R. Pechiney of Salindres, France, and many others, for valuable information which they have freely furnished, and also to Dr. W. R. Orndorff, of Cornell University, for substantial aid in the preparation and editing of this report.

CHEMICAL AND PHARMACEUTICAL PRODUCTS.

By SPENCER B. NEWBURY.

I.—SULPHUR AND ITS DERIVATIVES.

The world's supply of sulphur is still chiefly obtained from Sicily, and no new sources of great importance have been developed during the last few years. Sicily produces about nine-tenths of all the sulphur mined in Italy, the remaining one-tenth coming from the Romagna and Tuscany. In spite of the general replacement of sulphur by pyrites for sulphuric acid making in Europe, the production in Sicily has not declined. This is chiefly due to the great extension of the use of sulphur for other purposes, such as the manufacture of carbon disulphide, and the treatment of grape vines to combat the oidium and mildew. The following table, compiled in part from figures given by Mr. A. S. Malcomson,* and in part furnished privately by William Smith & Co., of Glasgow, shows the total production of sulphur in Sicily during the past six years, and also the amount exported each year to various countries:

Production and distribution of Sicilian sulphur.

[Tons of 2,240 pounds.]

Shipments to —	1883.	1884.	1885.	1886.	1887.	1888.
America	96,629	94,929	99,378	98,590	88,593	128,593
Turkey and Greece	14,537	8,318	16,741	24,295	25,541	7,665
Belgium and Holland	8,916	7,489	10,753	9,579	6,681	10,326
Spain and Portugal	20,540	14,938	20,003	36,833	23,826	19,332
France	63,602	65,098	58,264	54,280	56,221	53,927
England	41,788	40,760	33,402	30,246	31,086	37,455
Germany	7,232	6,622	6,103	8,698	9,669	12,666
Russia	10,413	12,831	13,420	10,570	13,866	23,191
Sweden, Norway, and Denmark	1,010	744	1,138	1,916	1,776	3,602
Italy	66,810	56,292	49,415	48,658	46,818	48,436
Austria	4,915	6,037	5,965	5,800	7,654	8,573
Sundries					705	1,235
Total	336,392	314,058	314,582	329,455	312,446	355,361

*Journal Society Chemical Industry, 1889, p. 313.

It will be seen from this table that the production of sulphur in Sicily during 1888 has been greater than in any previous year, and also that considerably more than one-third of the total product comes to the United States, where it is still very largely used in the manufacture of sulphuric acid. The only other important sources of sulphur are Cove Creek, Utah, where 3,000 tons were produced in 1887, and Japan, from which source a constantly increasing quantity is imported into the United States, amounting in 1888 to 6,332 tons. According to a recent statement published in the French "Bulletin du Ministre des Travaux Publics," the original quantity of sulphur in the Sicilian mines, before the workings were commenced, is estimated at 65,000,000 tons, and the amount produced up to 1885, at 10,351,091 tons. As about one-third of the sulphur is lost in treatment, it is probable that about 15,000,000 tons have been taken from the mines. According to this estimate, at the present rate of production the Sicilian mines may continue to be worked for another century.

The present condition of the sulphur industry in Sicily has been lately reviewed at considerable length by Philip Carroll, consul of the United States at Palermo.* The process followed in the mining of the ore and the extraction of sulphur are still very primitive. The productive territory is so largely subdivided that there is little opportunity to establish the mining industry on a large scale. The proprietors of the land rent the mines at a high price for short periods, therefore no economy is practiced; the richest portions only are exploited, and the rest abandoned. As no good maps of the mines exist, the supports of the different levels often do not correspond, and frequent caving in of the mines takes place.

A very full description of the sulphur deposits in Sicily, with maps and sections, and a valuable account of the methods of treatment of the ore now practiced, is given by Sorel in Vol. v, Part I, of Fremy's "Encyclopédie chimique" (Paris, 1883). The deposits of sulphur on the continent of Italy appear to be nearly exhausted, and the amount of sulphur obtained in that region is decreasing. The total amount of sulphur produced in northern Italy in 1886 was 23,274 tons; in 1887, 21,663 tons. The basin of the Romagna is now nearly worked out, and the Cesena company, which has heretofore been a large producer, has lately failed. (See *Chem. Zeit.*, 12, 1659.)

METHODS OF EXTRACTION OF SULPHUR.

But little progress is made in methods of extraction of sulphur from the ore. The crude and wasteful method of burning the ore in "calcaroni" or kilns, in which a large part of the sulphur contained is consumed to furnish heat for the extraction of the remainder, is still chiefly used. These calcaroni are often of great size, sometimes hav-

*Consul's report to State Department, No. 92, April, 1888.

ing a capacity of 5,000 tons of ore, and requiring several months for the burning of a charge. Owing to the torrents of sulphur dioxide which are liberated during the smelting, causing great damage to the agriculture of the district, the burning is prohibited by law during the last six months of the year. If the heat of the burning sulphur could be completely utilized, it has been calculated that one-ninth of the total amount would furnish sufficient heat for the extraction of the remainder. In practice, however, only 65 to 70 per cent. of the sulphur contained in the ore is recovered. With a loss of three-fifths of the ore, due to imperfect mining methods, and 35 per cent. in extraction, less than one-fourth of the sulphur contained in the deposits is finally obtained.

An improvement in the calcarone has been introduced by P. Le Neuve Foster, which is said to increase the yield of sulphur by 30 per cent. In this form, after the burning in the calcarone is completed, a current of air is drawn over the hot spent ore and passes by a flue into a kiln filled with fresh ore. By the waste heat of the calcaroni the melting of a second charge is thus effected. This apparatus is figured and described by C. G. Warnford Lock in the Journal of the Society of Arts, 1884.

For many years earnest attempts have been made to devise some process by which the extraction of sulphur from the ore may be accomplished more rapidly and completely than by means of the calcaroni, and which may also be carried on during the entire year. Many ingenious methods have been suggested and tried, but owing to the high cost of fuel and the difficulty of obtaining skilled or intelligent labor, none of these processes can be said to have come into general use. Among the plans which have been tried may be mentioned the following:

(1) *Fusion by hot air*.—The ore is placed in stone chambers, and a current of air and hot gases from a fire is made to circulate through the mass of mineral. Although this process avoids the liberation of offensive sulphur dioxide vapors, the extraction of the sulphur proceeds very slowly, and the heating of the charge is irregular. On account of the cost of fuel and the more difficult manipulation, this process has not resulted in any important economy.

(2) *Fusion by superheated steam*; process of Gill, modified by Thomas and others. This plan seems to offer better prospects of success, and has been introduced at several points in Sicily. On account of the difficulty of obtaining good water for feeding the boilers, however, and also because of the high first cost and rapid deterioration of the apparatus and the large amount of fuel required, the use of the process has extended but slowly.

(3) *Extraction by carbon disulphide*.—This method of separation of sulphur, though very complete and effective, requires so many minute precautions in the manipulation of the extremely volatile and

dangerous solvent, that it has taken little root in Sicily. It was lately tried on a large scale near Naples by the Marquis de Sassenay, but with unsatisfactory results. The process is, however, at present used in Upper Silesia.*

(4) *Fusion by immersion in saline solutions.*—This process, suggested by Thomas in 1805 and recommended by Balard in his report on the Paris Exposition of 1867, is based upon the fact that a strong solution of a soluble salt, as calcium chloride, may be heated without boiling to a temperature of more than 120° C., or several degrees above the melting point of sulphur. If the sulphur ore is immersed in such a heated solution, the sulphur melts out and collects at the bottom of the vessel. This method was tried in Sicily twenty years ago, but owing largely to a lack of cheap supply of calcium chloride at that time the attempt was not successful. Now, however, calcium chloride is produced on an enormous scale as a waste product in the ammonia-soda industry, and this process has lately been put once more into operation with success by Mr. de la Tour Debreuil. According to Vincent† there were in 1883 nine complete plants on the de la Tour Debreuil system in operation in Sicily.

(5) *Extraction by sublimation.*—In Romagna the deposits of sulphur ore contain a considerable proportion of bituminous matter, amounting to 2 or 3 per cent., which gives the crude sulphur extracted by the calcaroni a very dark color and lessens its market value. For a long time these bituminous ores have been treated in part by direct distillation in fire-clay or cast-iron pots called “doppioni.” A large number of these are placed in a double row in a long furnace and heated by one fire. Each pot is provided with an outlet tube connecting it with a similar vessel outside the furnace which serves as a condenser, and in which the distilled sulphur collects. The product is of good color and quality, since at the high temperature at which sulphur distills the bituminous impurities are destroyed. This process is not very generally employed for the extraction of sulphur from the ore, and the “doppioni” are chiefly used for the purification by distillation of the black sulphur obtained from the calcaroni.

Mr. Charles Dubois, of Marseilles, whose products were shown at the Exposition, has invented an apparatus for the separation of sulphur from the ore by distillation in a current of steam at a temperature not exceeding 150° C. At this temperature the steam carries over a large amount of sulphur vapor, which condenses to flowers of sulphur on cooling. The apparatus consists of a revolving iron cylinder, in which the materials are acted upon by superheated steam. This cylinder is mounted on hollow trunnions, one of which serves for the admission of steam, while the other provides an escape

* Mrowec, Dingler's Pat. J, 1879, p. 86.

† Bull. de la Soc. Chimique, 1883, p. 528.

for the sulphurous vapor. The retort has a rotary motion imparted to it by means of a worm and wheel which secures an even distribution of heat, and constantly presents fresh surfaces of the material to the action of the steam, and is inclosed in a chamber of brickwork in which the products of combustion from the furnace are caused to circulate. Steam is supplied to the apparatus by a pipe, which after passing through the heating chamber surrounding the retort, enters the latter through one of the trunnions, and is distributed throughout the materials by perforated branch pipes. The outlet communicates with a box in which the vapors can be examined, and directed into various receptacles according to their quality.*

Six to eight tons of ore can be treated in one operation, lasting 12 to 15 hours, for material containing 35 to 40 per cent. of sulphur. Each apparatus is claimed to be capable of producing, from rich material, 10,000 kilogrammes† of sulphur per day. The amount of coal required for heating and motive power is 200 kilogrammes per ton of 40 per cent. mineral treated. Only 1 or 2 per cent. of sulphur is left in the residues. The vapors which issue from the retort enter a condensing chamber with an inclined floor, in which the sulphur condenses in the form of flowers, while the water is drained off.

The inventor claims to avoid by this method the great loss of sulphur which occurs in ordinary methods of extraction, and also the additional loss which takes place in the special distillation required for the manufacture of flowers of sulphur. On account of the low temperature at which the sublimed sulphur is produced, it is claimed to be in an unusually fine state of division, and therefore to adhere far better to the vines when used for destroying parasites. This process is now in operation in four works, namely, at Marseilles, Frontignan (Herauld), Almeria (Spain), and Leghorn (Italy). The process of Dubois is also stated to be especially applicable to the treatment of the spent iron oxide of the gas works. These residues sometimes contain as much as 60 per cent. of sulphur, but their treatment has always presented many difficulties. On account of the large amount of tarry matters which they contain, extraction by carbon disulphide is impracticable, and they are therefore usually burned to sulphur dioxide for the manufacture of sulphuric acid. At the works of the inventor, at Cap Janet, Marseilles, more than 10,000 kilogrammes of gas-purifying residues are treated daily. Licenses to use the process have lately been granted to manufacturers in Germany, Austria, Roumania, and Russia. The process of Dubois appears to differ only in mechanism from the older process of Gerlach‡, which is described by Sorel (p. 56).

* English patent No. 7129, May 27, 1886.

† A kilogramme is 2.2055 pounds avoirdupois; 2.6803 pounds troy.

‡ Dingler's Pol. J., 230, p. 61.

Sulphur is also to some extent obtained by the distillation of pyrites, especially in countries far removed from centers of production of sulphur. Very recently, also, the regeneration of sulphur from the tank waste of the Leblanc soda process has been made successful, and is now in actual operation on a large scale in England and France. This industry, which promises to rival the Sicilian mines in furnishing the world's supply of sulphur, will be fully described in its proper place under the head of alkali manufacture.

REFINING OF SULPHUR.

Crude sulphur as it comes from the *calcaroni* contains 3 or 4 per cent. of earthy impurities, but is pure enough to be directly used for the manufacture of sulphuric acid. If, however, the sulphur is to be used in the manufacture of gunpowder, matches, or pharmaceutical products, it must be purified by distillation. This process is carried on in Italy, Belgium, and especially in France in the neighborhood of Marseilles. There are at present six large sulphur refineries near Marseilles, and also one at Montpellier, two at La Nouvelle, one at Narbonne, and one at Bordeaux. About 65,000 tons of crude sulphur are annually imported into France, and nearly the whole of this is refined at the above establishments.

FRANCE.

The members of the firm of A. Boude et Fils are well known in connection with the development of the sulphur refining industry. They have received many awards at previous exhibitions since 1867. The most accurate information which has been given to the world in regard to the process of sulphur distillation is contained in a pamphlet entitled "*Les Raffineries de Soufre de Marseille*," published by Mr. F. Boude in 1876. This firm manufactures both flowers and roll sulphur. The distillation of the crude Sicilian sulphur is effected in apparatus very similar to that generally figured in chemical text books, consisting of a series of furnaces, each containing a D-shaped cast-iron retort, one end of which is provided with a tightly-fitting plug, while the other end is connected with the vaulted brick condensing chamber by means of a cast-iron neck. The flame from the fire beneath envelops the retort, and serves also to heat a large iron pot placed above the furnace. The retort is charged with crude sulphur. The melting-pot at the top of the furnace is also filled with the same material, and as the distillation begins in the retort the sulphur in the upper vessel melts, and when quite liquid is admitted to the retort as required by means of a stop-cock. The vapors of sulphur pass from the retort into the condensing chamber, where they fall in flakes of flowers of sulphur. Many precautions are necessary in order to obtain the best results. If the heat is too intense, the flowers of sulphur take a brownish tint, and are found to contain a

certain amount of semi-fused vitreous sulphur ("soufre candi"). This substance is also produced if the temperature of the condensing chamber is allowed to rise above 111° C. It can only be used by remelting to roll sulphur or grinding to a powder, which is very inferior to flowers of sulphur in its power of adhering to the vines. Mr. Boude has patented a number of modifications in the distilling apparatus, by which he claims that the production of vitreous sulphur has been greatly reduced.

In the manufacture of roll sulphur the same process is followed; the condensing chambers are, however, maintained at a higher temperature, and the operation is continuous. Roll sulphur is used in the manufacture of gunpowder, matches, ultramarine, and sulphur tapers for fumigating wine casks, and also in the bleaching of straw and textile fibers, clarification of sugar juice, and for many other purposes. Flowers of sulphur are chiefly used in the vulcanization of rubber, in the preparation of certain colors, and especially for combating the "*oidium*" and other cryptogamic diseases of the vine. The flowers of sulphur are found by microscopical examination to consist of minute spheroidal masses joined together in groups and strings; for this reason this form of sulphur attaches itself more firmly than the powdered to the leaves and tendrils of the vines. A given weight of flowers of sulphur occupies nearly twice as great a volume as the same weight of the pulverized material.

The use of sulphur in treating the various diseases of the vine is well reviewed in a pamphlet by Mr. Frederick Boude, entitled "Le Soufre et la Vigne." According to Mr. Boude, the *oidium* is best controlled by blowing the finely divided sulphur on to the vines by means of a bellows. This should be done twice each year, immediately before and after the blossoming of the vine. A third treatment is sometimes necessary. For three applications, 60 to 80 kilogrammes of sulphur per hectare (53 to 72 pounds per acre) are required. Sulphur is also of great value as a protection against *mildew* and *anthracnose*. For the destruction of *phylloxera*, sulphur is employed in the form of bisulphide of carbon or potassium sulphocarbonate. Professor Balbiani has recommended the use of a mixture of creosote oil, naphthalene, and lime. Messrs. A. Boude et Fils have patented for the same purpose a mixture called by them "*soufre phénique*," consisting of sulphur, lime, and carbolic acid; this is a pulverulent substance, convenient to transport, and is easily applied to the vine in the same manner as sulphur.

Refined sulphur is admitted to France free of duty, and a considerable quantity of sulphur is refined in Italy and Belgium and exported to France. In Italy an export duty of 11 francs per ton is imposed upon all crude sulphur shipped. Therefore, in consequence

of the unfavorable situation of the industry in France, refineries have lately been erected by French capitalists at Catania, in Sicily.

The factories of the Messrs. Boude at Marseilles consist of fifteen furnaces and the same number of condensing chambers, and have a total capacity of 25,000 kilogrammes of flowers of sulphur and 10,000 kilogrammes of roll sulphur per day. The actual annual production of the works is 12,000 tons of refined sulphur.

The exhibit of Messrs. Boude included an interesting collection of specimens of native sulphur from all parts of the world; beautiful crystalline masses of sulphur and celestite from Sicily; specimens of crude, refined, sublimed, ground, roll and vitreous sulphur.

The Raffineries de Soufre Méridionales, director, Mr. L. Vézian, Marseilles, is one of the most important of the Marseilles refineries, and produces annually 20,000 tons of refined sulphur, of which 12,000 tons are in the sublimed form. The exhibit consisted of a display of the various forms of refined sulphur; compositions for the treatment of vines, containing sulphur, sulphate of copper, and lime; sulphur tapers (*mèches soufrées*) on paper, cloth, and asbestos for fumigating wine casks, and drawings of an improved form of distilling furnace lately introduced in these works.

Louis Chambon fils, and Louis Esmieux, of Marseilles, also exhibited the products of the refining of sulphur.

UNITED STATES.

An interesting device in the use of sulphur for disinfecting purposes was shown in the American section by Seabury & Johnson, of New York. This is the so-called "sulphur candle," consisting of a circular tin box containing a block of sulphur with a wick in the centre. When the wick is lighted it continues to burn until all the sulphur is consumed, furnishing a constant and convenient source of sulphur dioxide for purposes of disinfection.

SULPHUR DIOXIDE AND SULPHITES.

Sulphur dioxide (or sulphurous acid) is now very largely used for the production of cold in ice-machines, and also for disinfecting and bleaching, and for these purposes it is now manufactured and condensed in a liquid form in glass siphons and copper cylinders, which can easily be shipped to any point where the material is required. Sulphur dioxide for ice machines and for the manufacture of sulphites is often required to be free from air, and is, therefore, made by the decomposition of sulphuric acid, either by heat alone, or more generally by heating the acid with coke. For this purpose, large bottles of stoneware or glass, filled with coke, are mounted in deep sand-baths over a furnace. Sulphuric acid is gradually admitted, and becomes decomposed in contact with the hot carbon

with the formation of water, carbon dioxide, and sulphur dioxide. The gases may then be passed through water contained in a series of absorption bottles, yielding a solution of sulphur dioxide, or the latter in gaseous form may be used directly for the manufacture of bisulphite of soda or lime.

Sulphite of soda is generally made by the methods followed at the *Établissement Kuhlmann*, at Lille, by allowing the sulphur dioxide from burning sulphur to ascend a wooden tower filled with crystals of sodium carbonate, to which a further quantity of carbonate is added at the top, from time to time, as required. Carbon dioxide is liberated, and the bisulphite of soda formed dissolves in the water of crystallization of the carbonate, and issues at the bottom of the tower as a concentrated solution; this is then evaporated to crystallization, or, if the neutral sulphite is required, an amount of carbonate equal to that decomposed is added to the solution.

Sulphite of lime is made by passing sulphur dioxide, usually from the burning of the sulphur, over shelves upon which slaked lime has been spread in a thin layer. This compound is largely used in the United States in the manufacture of wood pulp.

Sulphite and bisulphite of soda and sulphite of lime were exhibited by *Pilon frères et Buffet*, Chantenay; the *Établissement Kuhlmann*, Lille, and by *A. Labarre et Cie*, Montreuil-sous-Bois. The representative of the last-named firm stated to the jury that the product of the works is 1,800,000 kilogrammes per year, chiefly of sulphite of lime. This is largely used in the decolorization of sirups in sugar refining. The actual decolorization is effected by potassium permanganate, and the excess destroyed by the sulphite. Other uses to which the sulphite of lime is applied are the preservation of beer, white wine, cider, meat, and the removal of putrid odor from starch. Sulphite of soda is used for preserving canned fruits.

In the Belgian section a fine exhibit of bisulphites and sulphites, sulphurous acid, hyposulphites, and other products was made by the firm of *David & Debouche*, Moustier-sur-Sambre. Similar products were shown by *Werotte*, of Liège.

BISULPHIDE OF CARBON, SULPHOCARBONATES.

The manufacture of bisulphide of carbon on a commercial scale was first carried on in France soon after 1840, by *Peroncel* and by *Deiss*. They employed vertical iron retorts, coated inside and outside with fire-clay; these were charged with charcoal, and into each sulphur was introduced by means of a tube extending nearly to the bottom. The retorts were heated in a furnace and surrounded by burning coal. It is stated that a retort lasted only about a week, and produced about 200 pounds of carbon bisulphide per day. The

credit of having perfected the process is due to Deiss, who, it is stated, introduced improvements in the apparatus and methods of working which caused the price of bisulphide of carbon to fall within a few years from 2 francs per ounce to 50 centimes per pound. At the present time the manufacture is conducted on an enormous scale, as the use of the product for various purposes is rapidly increasing. The process presents some difficulties, owing to the explosive character of the bisulphide vapor when mixed with air. Great pains must be taken to prevent the entrance of air to the apparatus; this is not a simple matter, since a number of openings are required for the introduction of sulphur and charcoal into the retort, as well as for the withdrawal of ashes. The high temperature at which the operation is carried on, also, renders the preservation of tight joints a matter of some difficulty. Another serious obstacle is the tendency of sublimed sulphur to condense in the exit tube and stop up the passage, necessitating frequent stoppage of work for the purpose of freeing the outlet from obstruction. The apparatus at present used consists of a number of vertical retorts of cast-iron (or better of earthenware and glazed on the inside), about $5\frac{1}{2}$ feet in height, and 20 by 12 inches internal diameter. Several of the retorts are supported above the fireplace of a furnace, in such a manner that each one may be completely encircled by the flame. Each retort is protected from direct contact with the fire by a mantle of fire brick. The exit pipe issues from the top of the retort, and is inclined upward to allow the condensed sulphur to flow back as completely as possible. An inclined tube also enters the retort at the bottom, and serves to admit the supply of sulphur in a melted state. The retort is charged with charcoal by means of a lid in the cover; heat is applied until the proper temperature is reached, and sulphur is gradually admitted at the bottom of the apparatus. The bisulphide of carbon formed passes out by the exit tube at the top, and is condensed in the usual manner.

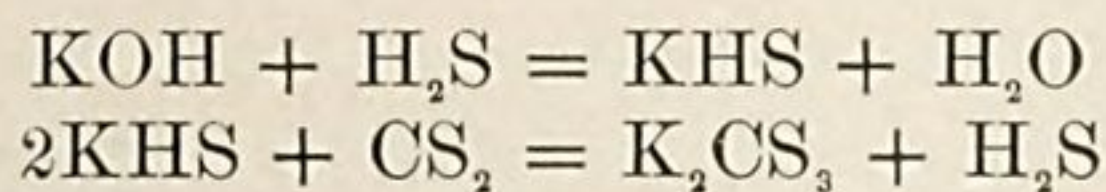
A full description of the most improved modern forms of apparatus for the manufacture of bisulphide of carbon, with drawings of the retorts and details of the condensing arrangements, is given by Ignatius Singer in the *Journal of the Society of Chemical Industry* of February 28, 1889 (p. 93).

Two important manufactories of this product were represented in the French section.

The Société Marseillaise de Sulfure de Carbone is the direct successor of Mr. Edouard Deiss, one of the founders of the industry in France; the manufacture has been carried on in the name of the society since 1881, and the works are under the direction of Mr. Gustave Deiss, son of the founder of the establishment. During the eleven years which have elapsed since the last exposition the production of these works has increased from 2,000,000 to over 6,000,000

kilogrammes. The latter amount represents the present production, and is greater than that of all the other manufactories in France together, and shows this factory to be the most important of its kind in the world. The recent great increase in the demand for bisulphide of carbon is due to its rapidly extending use in destroying the phylloxera.

Among the improvements in the process which this firm has introduced, the most important is probably the method of utilizing the uncondensable vapors, which are formed in large quantities, and which have hitherto been burned to sulphur dioxide and allowed to escape by the chimneys. These gases consist chiefly of hydrogen sulphide, formed in consequence of the presence of a considerable amount of hydrogen in the charcoal employed, and constitute a serious inconvenience on account of the loss of sulphur they occasion, and the nuisance produced by the escape into the air of large volumes of sulphurous fumes. In order to remove this objection, and at the same time to furnish a valuable by-product, Mr. Gustave Deiss introduced the device patented by him in 1882, of absorbing the hydrogen sulphide in solution of caustic potash, and transforming the resulting hydrosulphide into the sulphocarbonate of potash by the addition of carbon disulphide.



The sulphocarbonate so produced is very largely employed in the same manner as bisulphide of carbon in the treatment of vines attacked by the phylloxera. Under the superintendence of the French phylloxera commission there were employed for this purpose in 1882, 821,327 kilogrammes of sulphocarbonate (Muillefert, *Comptes Rendus*, 96, p. 180). As the amount of this by-product which could be produced by the Société Marseillaise in the manufacture of their enormous output of bisulphide of carbon would be far in excess of the demand, even in view of the great consumption of sulphocarbonate shown by the above figures, the hydrogen sulphide not required for this purpose is burned to sulphur dioxide; this is conducted into lead chambers and converted into sulphuric acid. The acid so produced is very pure and free from arsenic and iron.

The purification of bisulphide of carbon is effected by washing with lime water and distilling over vegetable oil, which has the property of retaining to a large extent the disagreeable odors of the crude product. In addition to its use as an insecticide, bisulphide of carbon is employed for many other useful purposes. The following list of its chief applications is given by Singer in the paper to which reference is above given.

- (1) For the extraction of fats and oils from seeds.
- (2) For the extraction and recovery of oils and fats from bones,

stearine waste, dried axle grease, the pressings (greaves) from tallow, sanza (the husks of olives after leaving the presses), and a large number of other waste products.

(3) For the extraction of oil from rags and cotton waste used in cleaning machinery, leaving both oil and rags in a fit state for use.

(4) For cleaning wool and recovering the fat therefrom.

(5) As a solvent for chloride of sulphur in vulcanizing caoutchouc and in water-proofing.

(6) For the extraction of sulphur from poor ores.

(7) For the recovery of grease from soap-suds in wool washing.

(8) For killing weavils in grain. (A small quantity mixed with the grain in a closed chamber is said to kill even the larvæ.)

(9) In Australia carbon disulphide has been extensively used for killing rabbits.

(10) An emulsion of carbon disulphide in water, which is easily made by the addition of a small quantity of sulpho-ricinoleate, is used for killing parasites on plants, and is largely employed in France and Germany for the extermination of the phylloxera.

(11) As a solvent for phosphorus in electro-gilding.

(12) In prisms, on account of its great refractive powers.

Bisulphide of carbon is also very useful for producing low temperatures, and as an antiputrescent.

Mr. Frederic Herubel, of Petit Quevilly, near Rouen, a manufacturer of soaps and chemical products, also exhibited bisulphide of carbon. In a paper read before the Société Industrielle de Rouen, Mr. Herubel describes the improvements he has introduced in the process of manufacture, which have for their object the avoidance of danger of explosion due to the entrance of air into the apparatus. The following brief outline of the paper gives the most important features of the invention.

Owing to the constant accumulation in the retorts of the ashes from the charcoal and residues from the crude sulphur used, it is from time to time necessary to interrupt the operation and open the retorts in order to remove the obstruction. When the tubes joining the retorts with the condensers are disconnected, air is gradually drawn into the condensing tubes and chambers by the absorption of the gases with which these are filled. An explosive mixture is thus formed, which through careless ignition has often produced very destructive accidents. To avoid the entrance of air, Mr. Deiss patented many years ago the device of filling the tubes of the condenser with water during the interruption of working. According to Mr. Herubel this does not give satisfactory results; he therefore recommends another plan, which has been made the subject of a patent. Mr. Herubel introduces into the condenser, on disconnecting from the retorts, a slow current of carbon dioxide generated by the action of hydrochloric acid on limestone. This gradually takes the place

of the absorbed gas, and effectually prevents the entrance of air and consequent danger of explosion.

II.—SULPHURIC ACID.

MATERIALS OF SULPHURIC ACID MANUFACTURE.

The use of sulphur for acid-making has constantly diminished in Europe, until now no acid is made from sulphur except at works near the sulphur deposits (as in Italy, southern France, and at Cracovie in Galicia), or in case acid is required for special purposes to be free from arsenic and iron. Acid for use in the Leblanc soda process is now invariably made from pyrites. When pyrites first began to take the place of sulphur in acid-making, the supply of this mineral was chiefly obtained from Westphalia, Hungary, France, Belgium, and Ireland. The mineral found in these localities contains little or no copper, and has therefore been gradually superseded by the enormous quantities of cupriferous pyrites which have lately been exported from Spain and Portugal. Analysis of the Spanish (Rio Tinto) pyrites shows it to have the following composition (Weldon, Jour. Soc. Chem. Ind., 1883, p. 4):

Sulphur.....	per cent..	49.5
Iron.....	do....	43.0
Copper.....	do....	3.0
Lead.....	do....	1.0
Silver.....	grammes, per ton..	26
Gold.....	milligrammes, per ton..	180

According to the statement of the *Compagnie d'Exploitation des Minerais de Rio Tinto* the amount of gold is greater than the above figures indicate, namely, 1 gramme per ton.

The Spanish and Portuguese ore was introduced into England in 1859, and is now almost exclusively employed. Three great companies—the Tharsis and Rio Tinto companies in Spain, and Mason & Barry in Portugal—have for several years supplied nearly the whole English demand for pyrites, and have also exported 60,000 tons into Germany and a large amount into Austria. The production of pyrites by these three companies was, in 1887, as follows:

Companies.	Mined.	Exported.
	<i>Long tons.</i>	<i>Long tons.</i>
Rio Tinto, Spain.....	1, 182, 438	362, 796
Tharsis.....	635, 215	282, 653
Mason & Barry, Portugal.....	329, 128	80, 828
	2, 146, 781	726, 287

The amount mined in excess of that exported represents the quantity treated for copper in Spain and Portugal. This is chiefly done

by calcining the pyrites in the open air and extracting the copper from the cinders by the wet process. The total amount of copper produced in Spain in 1887 was 52,219 long tons. The great damage done to agriculture by the sulphurous fumes so produced has, however, caused open-air burning to be prohibited in Portugal, and it is probable that such prohibition will eventually become general. This circumstance, combined with the decline of the Leblanc soda process in England, has led to a fall in the price of pyrites to less than one-half the figures of a few years ago. It is probable that the new Chance process for the recovery of sulphur from the tank-waste of the Leblanc process (to be described farther on) will, by enabling alkali makers to use the same sulphur over again in their process, greatly diminish the importation of pyrites into England. The extent to which sulphur has been replaced by pyrites in England is shown by the statement that in 1887 there were imported 597,595 tons of pyrites and only 32,624 tons of sulphur.

In France native pyrites is chiefly used, owing to the circumstance that the leading acid-makers control the large deposits of this mineral at Sain-Bel, near Lyons, San Julien and Soulier, in the department of the Gard, and Soyons in Ardèche. As it was impossible to sell Spanish pyrites to existing companies in France, those interested in the Spanish mines have formed a company called the *Compagnie d'Exploitation des Minerais de Rio Tinto*, with a factory at Marseilles, where acid is made from Spanish ore, soda, and bleaching-powder by the Leblanc process, and copper, silver, and gold extracted from the residues. It was reported some years ago that the intention of the company was to establish works in Belgium, Austria, and the United States. These plans of extension have not been carried out, and are quite out of the question under the conditions which at present prevail.

A very interesting description of the existing state of the acid and alkali industry was given by the late Mr. Walter Weldon, in a paper read before the Society of Chemical Industry in London in 1883, and continued in later communications.* Mr. Weldon's first paper contains the following interesting paragraph:

To such a complexion has the Leblanc process come at last. Originally soda was its only commercial product, the hydrochloric acid produced during the first stage of it being turned to no account. In time a demand grew up for chlorine, the hydrochloric acid began to be utilized, and the manufacturers of Leblanc soda now sent into the market two products, by each of which they gained profits. Then their soda ceased to be profitable and became a kind of by-product which they continued to make only because they could not otherwise make chlorine. Now, Leblanc soda gives no profit at all, and chlorine none to speak of, and both have come to be regarded as secondary products, to be made only incidentally, and only because making them is essential to the application to certain ores of the wet method of extracting copper.

* *Jour. Soc. Chem. Ind.*, 1883, pp. 2, 434; 1884 p. 387.

In the United States large deposits of pyrites occur, chiefly in New Hampshire, Massachusetts, and Virginia. These deposits have been mined to a considerable extent, and produced in 1888 a total amount of 54,331 tons of pyrites. During the year 1887 there were imported from Canada and Spain 16,578 tons. The importation of sulphur from Sicily in 1888 was over 128,000 tons. It is evident from these figures that sulphur is still very largely used for acid-making in the United States. It was estimated* that in 1884 306,000 tons of acid were made from sulphur and 122,000 tons from pyrites. By a calculation based on the comparative production and importation of pyrites and sulphur in 1884 and 1888 we may conclude that the present quantities are approximately as follows: From sulphur, 390,000 tons; from pyrites, 163,000 tons. From this it appears probable that about the same proportion of the acid manufactured in this country is at present made from sulphur as was the case in 1884. The reason why this country, so remote from deposits of sulphur, stands alone in the civilized world in the general use of this material for acid-making is probably to be found in the greater cost of plant and higher charges for labor which the use of pyrites involves, and also in the large demand for acid in the profitable industries of petroleum refining and fertilizer manufacture, which makes the practice of minute economy unnecessary. Another cause of the hesitation of American manufacturers to accept the use of pyrites may perhaps be their isolated position in relation to centers of chemical industry, and the lack of trained chemical engineers capable of planning and superintending the more complicated pyrites plants. For the manufacture of medicinal or food products acid made from sulphur is generally employed, as it is free from arsenic, an impurity which is nearly always present in acid made from pyrites. Further, sulphur gives richer burner-gas than pyrites, since when the latter is used a portion of the oxygen of the air remains behind in the oxide of iron of the cinders. According to Dr. Lunge, 1 kilogramme of sulphur gives 6,199 litres of gas (a litre is about 1 quart), while the same weight of sulphur in the form of pyrites gives 8,145 litres. One-third to one-fourth more chamber-space must therefore be provided in the case of pyrites than in that of sulphur. In spite of these slight disadvantages there can be no doubt that pyrites is by far the cheaper source of sulphuric acid. Dr. Francis Wyatt estimates that by manufacturing acid at the pyrites mines the cost might be reduced from \$5.50 to \$4.20 per ton of chamber acid. To compete with this, brimstone must be sold at \$14 per ton, whereas the price in 1887 ranged from \$20 to \$25. The pyrites mined in the United States and Canada is of exceedingly good quality, contains 3 to 5 per cent. of copper, and is practically free from arsenic, and should therefore be decidedly better for acid-making than the Spanish ore. Generally

* Mineral Resources of the United States, 1883-'84.

speaking, the works near Philadelphia and in the South are still using sulphur, while in the more complete and modern plants in the neighborhood of New York and Boston pyrites is employed.

It was lately stated by Mr. E. K. Mussprat* that no important improvement in the manufacture of sulphuric acid has taken place within the past ten years, and little further improvement is to be expected, since with well constructed apparatus the loss of sulphur need not exceed 1 per cent., and the consumption of nitre is not greater than 2 per cent. of the amount of sulphur burned.

A brief description of the forms of pyrites burners now in use is given by Martyn, in the Report on Mineral Resources of the United States, 1883-'84, p. 890.

UTILIZATION OF PYRITES CINDERS.

The extraction of copper, silver, and gold from the residues of pyrites burning has become a great industry. In fact, in the case of the Spanish and Portuguese ores, which contain 3 or 4 per cent. of copper, the sulphuric acid produced from them may fairly be regarded as a by-product, while the copper and precious metals obtained from their cinders yield the most important return. A very large proportion of the ore mined is directly burned on the spot, in order that the residue may be treated for copper. In Portugal, where burning in the open air is severely restricted by law, the ores are piled up in heaps provided with flues and shafts for free circulation of air, and allowed to become spontaneously weathered and oxidized. The heaps are periodically lixiviated for the extraction of the valuable copper salts. In Spain and Portugal over 20,000 tons of copper are produced annually by the above methods from pyrites containing less than 3 per cent. of copper. (For a full account of the wet process of copper extraction as employed in Spain, see Fulton, *Jour. Soc. Chem. Industry*, 1886, p. 296.)

The cinders from the Spanish pyrites imported into England for acid-making are also treated for copper on a large scale. In 1884 15,200 tons of copper were obtained from pyrites cinders in Great Britain, as compared with 3,350 tons produced from other British ores. The Henderson wet process, with precipitation of the copper by iron, and of silver and gold by potassium iodide, is universally employed. The residue of iron oxide, or "purple ore," left after the extraction of the copper, finds a ready sale as an ore of iron; this is generally used for "fettling" in the puddling process, or made into blocks for the blast furnace. It brings a price which practically pays the cost of copper extraction. Thus all the constituents of the pyrites, sulphur, iron, copper, silver, and gold are utilized.

The wet process of copper extraction is generally known as Hen-

**Jour. Soc. Chem. Ind.*, 1886, p. 404.

derson's process, though first suggested by Longmaid in 1842. The pyrites cinders, in which the copper is present chiefly as sulphate and sulphide, are mixed with salt and calcined in a "blind roaster" or muffle furnace. After the roasting the copper is principally in the condition of chloride, with a considerable proportion of oxide. Hydrochloric acid is given off during the roasting, and condensed in the usual way. The roasted mass is then lixiviated, first with water, and then with weak hydrochloric acid obtained in the operation. This treatment removes the copper, silver, and gold, leaving the iron oxide, or "purple ore," behind in the vat. From the combined solutions the silver is recovered by the Claudet process, by precipitation with a soluble iodide; the gold is carried down with the precipitated silver iodide. The wet precipitate is then converted into metallic silver by scrap zinc, and the resulting solution of zinc iodide used for further precipitation of silver. The reduced silver is fused with lead and cupelled; the gold is separated from the silver by the usual method of parting. The copper liquors after the separation of the silver are boiled in tanks with scrap iron until all the copper is thrown down in the metallic state. The precipitate of copper is then washed, dried, smelted, and refined.

The following table, taken in part from Watson Smith's report on the Manchester Exhibition,* shows the quantities of metals extracted from pyrites cinders in Great Britain during the past few years:

Year.	Cinders treated.	Metallic copper extracted.	Extracted by Claudet process.	
			Gold.	Silver.
	<i>Tons.</i>	<i>Tons.</i>	<i>Ounces.</i>	<i>Ounces.</i>
1884	416,412	15,200	1,900	335,000
1885	407,700	14,880	1,840	328,000
1886	393,699	13,799	1,780	316,928
1887	410,996	15,000	1,875	330,000
1888	420,415	15,135	1,918	337,500

Twenty-one establishments are now in operation in Great Britain. One-eighth of the cinders recorded in the above table were treated at the works of Duncan McKechnie, St. Helens, Lancashire.

In the United States, where pyrites rich in copper is extensively mined and burned for acid-making, the treatment of the cinders for copper is also extensively practiced, especially at Elizabeth, New Jersey, Natrona, Pennsylvania, and in the neighborhood of New York. Ores rich in silica and containing little silver, as in the case of cinders from most American ores, are best smelted with raw pyrites in the form of "fines," producing a "matte" containing 50

*Jour. Soc. Chem. Ind., 1887, p. 697.

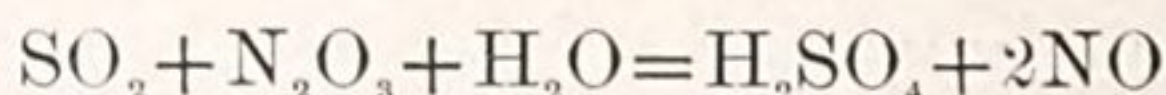
to 60 per cent. of copper. By this method the iron and any silver present are lost. If, on the other hand, 2 or 3 ounces of silver and but little silica are contained in the cinders, the Henderson wet process is employed.

THE LEAD-CHAMBER PROCESS.

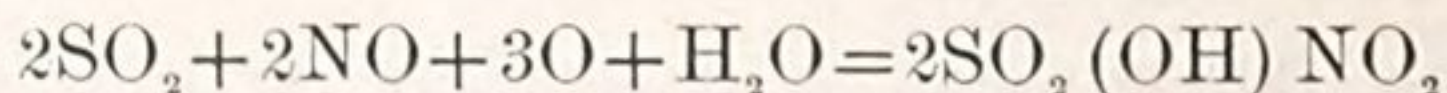
The use of the Glover tower for concentration and denitration has become nearly universal in Europe, but has been adopted in less than one-half the American acid-works. The process proposed by Benker & Lasne for preventing loss of nitrous fumes by introducing sulphur dioxide and steam before the gases pass into the Gay-Lussac tower, has not proved advantageous in England. The *Société de la Manufacture de Javel*, Paris, accomplish the saving of nitrous gases by injecting a spray of strong acid before the gases enter the tower. The spray of water, proposed by Sprengel as a substitute for steam in the lead chambers, is said not to have given good results.

THEORY OF THE SULPHURIC ACID PROCESS.

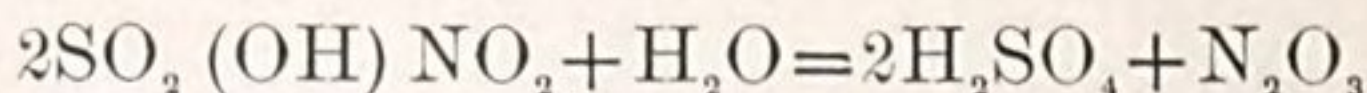
Within a few years the reactions which take place in the lead chambers have been carefully studied, chiefly by Professor Lunge,* of Zurich. As the result of his researches, Lunge concludes that the simple reactions generally given in chemical text-books do not correctly represent the actual transformations which take place. Nitrogen peroxide, NO_2 , is never formed except in absence of sulphur dioxide and steam, and is therefore rarely present in the chambers or in the nitrous vitriol. The chief carrier of oxygen is nitrous anhydride, N_2O_3 . This oxidizes the sulphur dioxide, and in presence of water produces sulphuric acid:



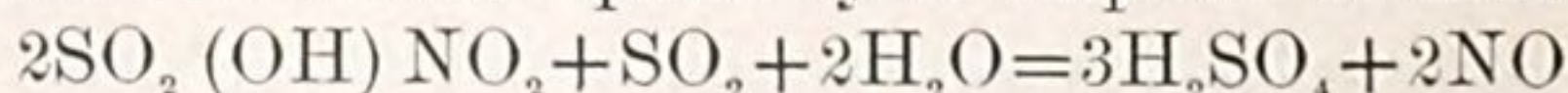
The actual process which takes place is probably the combination of sulphur dioxide, nitric oxide, water, and the oxygen of the air to form the "chamber crystals" or nitrosulphonic acid:



the nitrosulphonic acid is then decomposed by water, forming sulphuric acid and nitrous anhydride,



or, in presence of a further quantity of sulphur dioxide and steam,



A full discussion of the subject may be found in papers by Lunge (*Chemische Industrie*, 1884, p. 5), Raschig (*Annalen*, 248, 123), and Hamburger (*Jour. Soc. Chem. Ind.*, 1889, p. 184.)

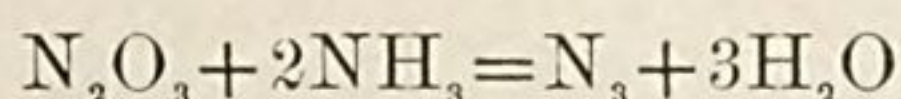
**Jour. Soc. Chem. Ind.*, 1888, p. 208, and *Ber. d. D. Ch. Ges.*, XXI, pp. 67-68.

SULPHURIC ACID FROM BLENDE.

According to a recent paper by Hasenclever,* a very considerable quantity of acid is now made in Germany as a by-product in the roasting of zinc blende. The furnace most used is that of Hasenclever & Helbig, a combined muffle and open roaster, described by Lunge (*Sulph. Acid and Alkali*, vol. I, p. 202). The ore is, however, only very incompletely desulphurized in these furnaces. Lunge states that 5 or 6 per cent. of sulphur remains in the ore, while an equal amount escapes with the fire gases. The Rhenania Company, of Aix-la-Chapelle, has lately made experiments with the new furnace of Eichhorn & Liebig. This is a rather complicated shelf-burner, heated by a separate fire. The results obtained show that the apparatus is very efficient, and reduces the sulphur to about 1 per cent., while only about 4 per cent. escapes with the fire-gas. About 3,000 kilogrammes of ore are treated every 24 hours.

PURIFICATION OF SULPHURIC ACID.

If the acid is to be concentrated in platinum, it is necessary that nitrogen compounds shall be completely removed. This is now almost always done by the addition of ammonium sulphate, which decomposes the oxides of nitrogen present, as follows:



The amount of ammonium sulphate needed is determined by testing a small quantity to ascertain how much must be added to reach the point at which the acid gives no further coloration (reaction for nitric acid) with a solution of ferrous sulphate. From one-tenth to one-half pound of sulphate of ammonia to every 100 pounds of acid is generally required. It is stated that the addition of ammonium sulphate causes also the precipitation of any selenium which may be present in the acid, and which would interfere with the use of the latter for parting precious metals by causing it to dissolve a certain amount of gold. Arsenic is usually present, generally as arsenious acid, in acid made from foreign pyrites. It may be removed by precipitation as sulphide. This is frequently done in case the acid is required for the preparation of food products or pure chemicals. In France, barium sulphide is generally employed as a precipitating agent, since it introduces no foreign substances into the acid. In Germany, precipitation is generally accomplished by gaseous hydrogen sulphide. American pyrites are generally free from arsenic, although a small amount is found in certain Canadian ores. Further, since 90 per cent. of the acid made in this country is used for the refining of petroleum and manufacture of fertilizers, for which purpose the

**Chemische Industrie*, 1884, pp. 78-86. (Illustrated.)

presence of arsenic is harmless, it is not probable that the purification of sulphuric acid by the removal of arsenic will ever be practiced in this country.

CONCENTRATION OF SULPHURIC ACID.

The strength of the acid from the chambers generally does not exceed 50° B., or about 62 per cent. H_2SO_4 . Such acid is strong enough for the manufacture of fertilizers, ammonium sulphate, and even for the salt-cake process. For petroleum refining, making nitric acid, and especially in the manufacture of nitrobenzene and nitroglycerine, stronger acid is needed. Acid from the Glover tower may reach a strength of 62° B., or about 82 per cent. pure acid, but beyond this strength the concentration must be carried on in platinum or glass stills. Acid from the Glover tower can not generally be concentrated in platinum, because it usually contains a large amount of sulphate of iron (ferric sulphate), caused by the action of the acid in the tower on the pyrites dust swept in with the burner-gas; this impurity would cause the formation of crusts on the bottom of the pan, and bring about its rapid destruction. When platinum stills are used, therefore, chamber acid is first concentrated in lead pans by the waste heat of the platinum stills or burners, to about 60° B., and then run into the stills. The great drawback in the use of platinum is its rapid corrosion, which is especially marked in the case of acid containing nitrogen compounds or large quantities of arsenic. Nitrogen compounds are removed by addition of ammonium sulphate, as already stated. According to Mr. W. H. Adams,* platinum stills would last almost indefinitely for the concentration of acid free from arsenic up to a strength of 65° B., or about 90 per cent. pure. This is strong enough for petroleum refining, but for the manufacture of nitro-compounds further concentration is necessary. Beyond this point, lead, iron, and other substances are rapidly precipitated and adhere to the bottom of the pan, and the chief injury to the apparatus takes place in the removal of the last portions of water. Within the last few years cast-iron retorts have been successfully used in the United States for final concentration, and are now employed on a large scale at extensive works near New York. Final concentration in iron retorts is also practiced in France at the *Établissement Malétra*, Rouen.

The question of the corrosion of the platinum stills has been carefully investigated by Mr. Scheurer-Kestner,† who has determined the comparative loss of platinum per ton of acid distilled: Acid of 98 per cent., 6 to 7 grammes per ton; and acid of 99.5 per cent., 9 grammes per ton. In the case of acids containing considerable quantities of

*Twenty years' Progress in the Manufacture of Sulphuric Acid, Proc. Amer. Inst. Mining Engineers, 1887.

†Comptes Rendus, April 29, 1878.

oxides of nitrogen, the corrosion was found to be over three times as great as the amount just stated. Platinum containing 30 per cent. of iridium sustains only about one-third as much loss as pure platinum. This alloy has been introduced for making stills, but proved to be too brittle for good service, and has been abandoned.

PLATINUM APPARATUS FOR CONCENTRATION.

Johnson, Matthey & Co., of London, made a very remarkable exhibit of platinum and platinum ware in the English section. In the case was displayed a pair of platinum retorts on the Delplace system, for the concentration of sulphuric acid. The retorts are of oblong shape, low and flat, with dome-shaped roof and central outlet pipe for vapors. Each retort is 1.5 metres long (or about 60 inches). One retort is placed on a slightly higher level than the other, and the two are connected by a tube in such a manner that the acid may flow continuously through both vessels. Acid of 60° B. flows into the first, and finally issues from the second at a strength of 66° B., containing then 97 per cent. H_2SO_4 , corresponding to 79 per cent. anhydride. The condensed vapors from the first retort show a strength of 5° to 15° B.; those from the second reach a strength of 62° to 63° B.

This form of concentrating apparatus is now chiefly used in the leading European works, and is also in use to some extent in the United States. One pair of retorts like those exhibited weighs about 2,000 ounces, costing about \$17,500, and will concentrate 10 tons of acid daily to 76 per cent. of anhydride, or 5 tons to 79 per cent.

The exhibit of Johnson, Matthey & Co. included also a great variety of articles in platinum; bars of platinum containing 10 per cent. of iridium, of X-shaped section, made for the use of the International Commission of Weights and Measures in the construction of "standard metres." At the laboratory of the commission, at Breteuil, near Paris, thirty such bars, costing \$2,000 each, are now undergoing comparison and adjustment. Beautiful specimens of the rarer metals contained in small quantity in native platinum, were also displayed, including about 3 pounds of granulated osmium, which can not be fused into a compact mass, and a fused ingot of iridium, weighing 54.4 ounces. Blocks of the three lighter metals, rhodium, palladium, and ruthenium, each of several pounds' weight and almost fabulous value, were also exhibited. It was stated that the stock of platinum ware carried by the firm often represents a value of £250,000 sterling.

F. Desmontis, Lemaire et Cie., Paris, also made a fine exhibit of platinum concentrating apparatus. The form of still chiefly made at present is circular in shape, and provided with a number of concentric partitions so arranged upon the bottom of the still that the acid traverses the whole series of compartments before making its

exit. This company owns also the patents for stills on the Faure & Kessler system, which consists of a pan of platinum surmounted by a dome of lead cooled by a water jacket. This form of apparatus is much lower in first cost than that consisting entirely of platinum. In Europe platinum stills are chiefly used, while in the United States the Faure & Kessler apparatus seems to be preferred. The following firms in this country are said to be using stills made by Desmontis, Lemaire et Cie:

The Bergenport Chemical Company (Charles Pratt), New York.
Phoenix Chemical Works (Gridley & Co.), New York.
James Morgan & Co., New York.
G. H. Nichols & Co., New York.
The Putnam Company Chemical Works, New York.
The Frankford Chemical Company, Philadelphia.
Harrison Brothers & Co., Philadelphia.
Chas. Lennig & Co., Philadelphia.
The Pennsylvania Salt Manufacturing Company, Philadelphia.
A. Cochrane & Co., Boston.
The Merrimac Chemical Company, Boston.
The Smith & Leyden Company, Atlanta.
The Clifton Chemical Works, Atlanta.
The Grasselli Chemical Company, Cleveland.
The Star Glass Company (W. C. De Pauw), New Albany.
James Irwin & Co., Pittsburg.
Malha & Chappell, Chicago.
The Marsh & Harwood Chemical Company, Cincinnati.
The Matthiessen & Hegeler Zinc Company, La Salle, Illinois.
Smith & Becker, Buffalo.
T. P. Shepard & Co., Providence.
The Talbot Dye-Wood and Chemical Company, Lowell, Massachusetts.

FUMING SULPHURIC ACID.

This product, known also as Nordhausen sulphuric acid, because formerly largely made at Nordhausen, in Prussian Saxony, is now made almost exclusively by the firm of M. D. Stark, in Bohemia. The acid is made from the Przibram slates, which contain considerable quantities of coal and iron pyrites. These slates are broken and piled up in heaps, and allowed to weather, with occasional sprinkling, for 2 or 3 years. During this period the pyrites becomes oxidized to ferric sulphate, with the formation of some aluminium sulphate. Finally, the mass is lixiviated, and the brown liquors so obtained are concentrated to a sirup; this is then run onto a floor and solidifies to "crude vitriol stone." The stone is then calcined in an open furnace to remove water and oxidize ferrous sulphate; the calcined mass consists then essentially of anhydrous ferric sulphate. This is broken up, charged into fire-clay retorts, and distilled; the fuming acid is condensed in clay receivers. The residue of ferric oxide remaining in the retorts, known as "*caput mortuum*," or col-

cothar, finds extensive use as a red pigment. It is ground under a millstone and again calcined with the addition of different quantities of salt, from 2 to 6 per cent., by which different shades of color are produced.*

Winkler's process for making sulphuric anhydride has lately been perfected, and has come into extensive use. Sulphuric acid is decomposed by heat into water, sulphur dioxide, and oxygen; the water is absorbed by a strong acid, and the mixture of sulphur dioxide and oxygen caused to recombine by passing the gases over red-hot platinized asbestos. The details of the process are kept secret by the manufacturers using it. According to Lunge, (vol. III, p. 385), Dr. Majert, at the Schlebusch works near Cologne, employs this method, decomposing the sulphuric acid in upright fire-clay retorts, the joints of which are luted with melted glass. The gases pass into a condenser and drying tower, then into cast-iron retorts filled with wire gauze shelves covered with layers of platinized asbestos. Hanisch finds that the combination of the gases is greatly aided by compression during the heating. The anhydride is also manufactured on a large scale by Chapman & Messel, of London, probably by a process similar to the above.†

Fuming sulphuric acid and sulphuric anhydride are largely used for dissolving indigo, sulphonating certain organic compounds in the manufacture of coal-tar colors, as eosine and alizarine, and also in the refining of ozokerite or mineralwax.

The most important exhibits of sulphuric and other acids at the Exposition will be noticed under the head of alkali industry.

III.—ALKALI MANUFACTURE.

GENERAL OUTLINE OF THE PRESENT POSITION OF THE ALKALI INDUSTRY.

Probably the most striking change in the whole field of chemical industry which the past 10 years have witnessed is the rapid growth and extension of the ammonia-soda process. Up to 1863, the date of the establishment of the first Solvay works at Couillet, the whole of the world's supply of soda (with the exception of the small quantity made from sea-weed and from cryolite) was manufactured by the Leblanc process. Soda manufactured by the ammonia process was exhibited by Solvay at the Paris Exposition of 1869, and again at the Vienna Exposition of 1873, where a diploma of honor was granted to the inventor for his services in the development and improvement of the process. At the Paris Exposition of 1878 Mr. Solvay was awarded a grand prize, having established a second factory in France at Varangeville-Dombasle, at which 40,000 tons of soda were annu-

* Lunge, *Sulph. Acid and Alkali*, vol. I, p. 630.

† See the report by Watson Smith on the London Inventions Exhibition, 1885, p. 50.

ally produced. The firm of Brunner, Mond & Co. had also established works to use this process at Northwich and Sandbach, in England. The annual production of ammonia-soda in 1878 was approximately as follows :

	Tons.
Couillet, France.....	7,500
Varangeville-Dombasle, France.....	40,000
Northwich, England	13,000
Total.....	60,500

At the same time there were produced by the Leblanc process 500,000 tons of soda in England, and also very large quantities in France, Germany, and Austria.

Since 1878 the progress of the ammonia-soda industry has been extremely rapid, while since 1880 the production by the Leblanc process has begun to decline. Since the soda produced appears in the various forms of soda-ash, crystals, and caustic, it is difficult to compare the production of the two processes in successive years. The amount of salt decomposed by each process gives, however, a fair basis for comparison. From the reports of the English alkali inspectors the following table has been compiled, showing the relative amounts of salt decomposed by the Leblanc and ammonia-soda processes, respectively, in Great Britain and Ireland since 1878:

Salt decomposed.

[Long tons.]

Year.	Leblanc.	Ammonia soda.	Total.
1878.....	535,154	16,230	551,384
1879.....	575,447	22,669	598,116
1880.....	648,587	27,416	676,003
1881.....	620,064	29,783	649,847
1882.....	598,833	56,914	655,747
1883..	602,921	77,015	679,936
1884.....	578,874	89,759	668,633
1885..	598,096	115,032	713,128
1886.....	584,323	137,220	721,543
1887.....	577,381	158,636	736,017
1888.....	546,703	209,200	755,903

The above table shows that about one-fourth of the soda now made in the United Kingdom is manufactured by the ammonia-soda process. Similar statistics in regard to France and Germany are not obtainable, but according to Hasenclever,* the relative advance of ammonia-soda has been far greater in those countries than in England. In 1887, of the total soda produced in Germany 75 per cent.

* Chem. Industrie, 10, 290.

was made by the ammonia-soda process, in France 60 per cent., and in Austria 47 per cent. In the United States practically all the soda manufactured is made by the ammonia process.

In the paper by Weldon, already quoted,* a very interesting sketch is given of the existing position of the rival soda processes, and it is stated that the cost of a ton of soda by the Leblanc process is certainly £1 sterling greater than by the ammonia process. Nevertheless, Mr. Weldon was of the opinion that the Leblanc process would soon be greatly cheapened, and would thus be enabled to hold its own. The economies which he believed would bring about this result are: (1) cheaper pyrites; (2) cheaper fuel in the form of gas made from waste coal, with recovery of tar and ammonia; and (3) recovery of sulphur from alkali waste. It may be of interest to inquire, briefly, to what extent these forecasts have been realized.

Shortly after the presentation of Weldon's paper the obvious decline of the Leblanc soda industry in England, and the critical position of many leading alkali manufacturers, led the Tharsis Company to break away from the combination of Spanish pyrites producers, by which the price of pyrites had been maintained at 6*d.* per unit (1 per cent. of sulphur per ton); this step produced an immediate reduction in the price of pyrites to 3*d.* per unit, or one-half the former rate. This price has prevailed up to the present time, but it is quite possible that the recent legislation in Spain and Portugal against burning pyrites in the open air, may compel the companies to send a larger part of their product to England to be burned, and may thus reduce the price still further.

In the use of gaseous fuel and recovery of tar and ammonia much progress has been made, though little advantage seems to have thus been gained by Leblanc process. In fact, the most complete solution of the problem of the recovery of ammonia from fuel-gas has been attained by Mr. Mond, the leading ammonia-soda maker of England.

The recovery of sulphur from tank waste has within the past year been made a practical success by the introduction of the Chance process, which is now in successful operation at nearly all the largest alkali works.

It thus appears that two of the three aids to the Leblanc process foreseen by Mr. Weldon have already begun to yield substantial results. The success of the process of sulphur recovery is, however, so recent that it is impossible as yet to form an estimate of its probable influence upon the alkali industry. Meanwhile there seems to be a general conviction among those most conversant with the present position of alkali manufacture, that the old process has made a very decided gain.

* Jour. Soc. Chem. Ind., 1883, p. 2.

The table given above shows that the decline of the Leblanc process since 1880 has been steady, and in view of the rapid increase in the total amount of soda produced, extremely unpromising for the continuance of the older process. There is, however, one important consideration which makes it improbable that the Leblanc soda industry will soon become extinct or even be reduced to small proportions; namely, the universal demand for bleaching powder, and the failure up to the present time to produce this substance by any other method than as a by-product of the Leblanc process. By a combination of all the leading alkali makers, it has been possible to maintain the price of bleaching powder for some years at a point at which the profits on this article practically compensated the losses on the soda produced, and thus enabled the industry to survive. Although this combination has been broken during the past year, it will probably be reëstablished on an equitable basis. Soda and sulphur can be abundantly and cheaply supplied from other sources; the manufacture of bleaching powder alone remains exclusively in the hands of the Leblanc soda makers. It is evident that the continued existence of the older process depends absolutely upon the failure of the attempts now being made to produce bleaching powder cheaply by other methods. For the present, at least, there is little prospect of these efforts proving successful on a large scale, and it is probable that the Leblanc process will continue to exist just to the extent necessary to supply the world's demand for bleaching materials.

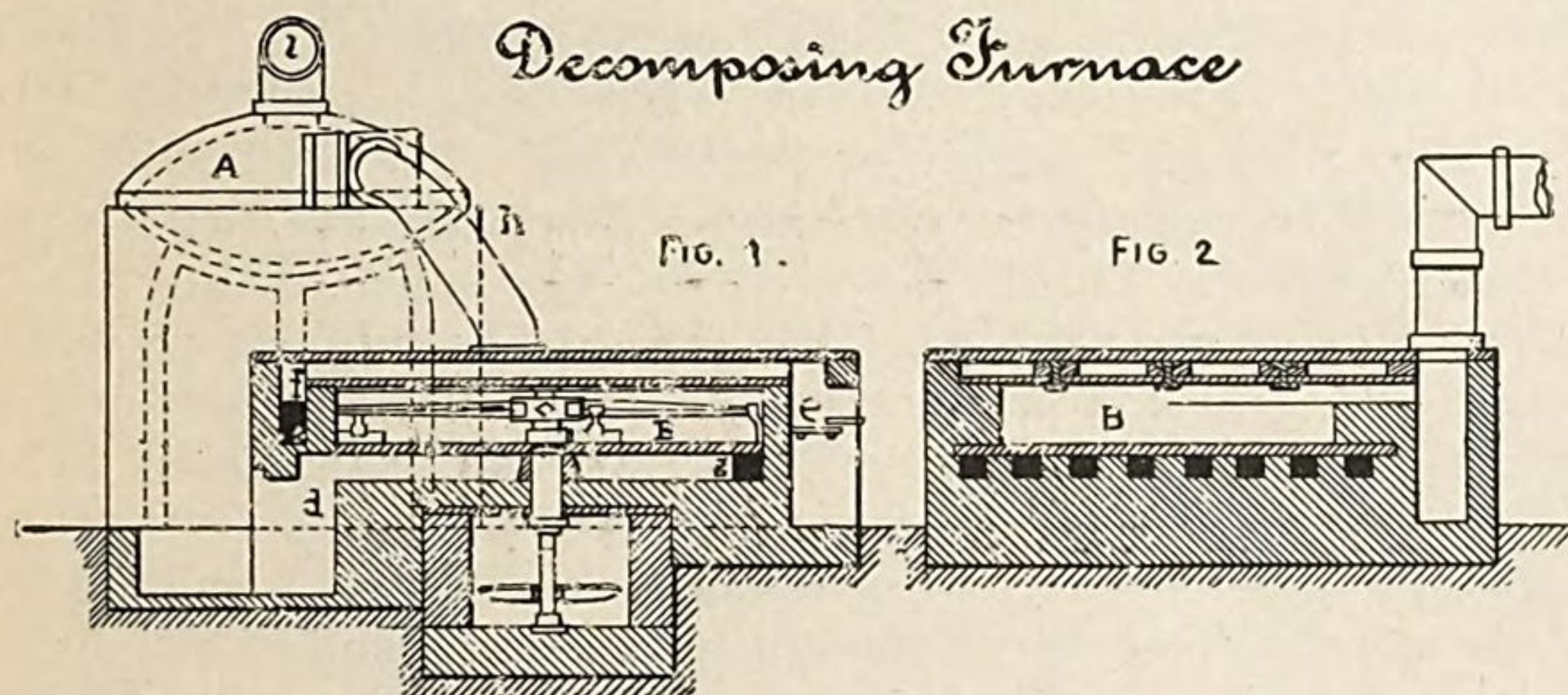
THE LEBLANC PROCESS.

MANUFACTURE OF SALT-CAKE.

In the salt-cake process, hand furnaces, consisting of an iron pan and fire-brick hearth, are still generally employed. Hand furnaces of the "plus pressure" type have generally been adopted in Lancashire. The revolving salt-cake furnaces designed by Jones & Walsh and by Mactear* have been introduced in a few works, but it is denied on good authority that they possess any advantage over the ordinary hand furnace. They are open furnaces in which the charge in the revolving pan is played upon directly by the flame of the fire, and in which the conversion of the salt into sulphate is completed in one operation. It is said that the cost of these furnaces is very great, and that the hydrochloric acid gas given off is greatly diluted with air. In the "plus pressure" hand furnaces, on the contrary, the charge is heated in a fixed pan without contact with the fire-gases, and is finally drawn out onto the hearth of a closed muffle, where it is roasted without entrance of air. The hydrochloric acid given off is therefore of high strength and free from dust and soot.

* Jour. Soc. of Arts, Feb. 4, 1881; Jour. Soc. of Chem. Industry, 1882, p. 26.

A new form of salt-cake furnace, designed to combine the advantages of the close roaster and the mechanical furnace, has lately been introduced by the St. Bede Chemical Company at Newcastle-on-Tyne.* The following figures show the chief features of the apparatus.



The furnace consists of an ordinary closed pan, A, in which the salt is decomposed, the acid escaping to the condenser by the pipe *l*. The charge is then transferred to the close roaster B, where it is "dried" by the heat of the fire-places *e* and *d*, from which flues pass above and below the roaster, terminating in transverse flues *f* and *g*, from which the fire gases are directed under the pan A, and serve for the first heating of the charge. The roaster is provided with a revolving stirrer driven by gearing below the furnace. The acid vapors from the roaster pass into the pan by the pipe *h*, and uniting with the pan-gases, pass off to the condenser. The first furnace of this kind was erected at the St. Bede works, at East Jarrow, in July, 1884. At the present time six furnaces are in operation at these works, and others have been erected at three of the largest alkali works in England. It is stated that these furnaces effect a saving of labor, give better condensation of hydrochloric acid, and diminish the escape of gases about the furnace to a greater extent than any other apparatus in use.

THE HARGREAVES PROCESS.

The direct conversion of salt into sulphate of soda by the action of sulphur dioxide and air, without the necessity of making sulphuric acid, was first patented by Hargreaves & Robinson in 1872. The process, which has from the first been successful, consists in submitting the salt, molded into cakes and charged into vertical iron cylinders, to the action of a current of sulphur dioxide and air from pyrites burners like those used in sulphuric acid manufacture. Hy-

* Jour. Soc. Chem. Ind., 1885, p. 316.

drochloric acid is given off and condensed as usual, while the salt is gradually converted into sulphate. The process has been fully described by Lunge,* and also by Commissioner Jenkins in the United States Reports on the Paris Exposition of 1878.

The use of the Hargreaves process has extended considerably during the last 10 years, especially in Lancashire, where all the plate glass now produced is made from Hargreaves salt-cake. In France, the *Société de Produits Chimiques d'Hautmont* (represented at the Exposition) has also introduced the process. The chief obstacle to the general employment of the Hargreaves process has been the high cost of the plant. This is, however, largely compensated by the excellent quality and freedom from iron of the sulphate produced. Wherever new apparatus is erected cylinders of larger size than those formerly used are now employed. In 1872 the usual size of cylinders was 12 by 12 feet. Works building new apparatus in 1886 have introduced cylinders 20 feet in diameter and 12 feet 6 inches high. In some of the older works the apparatus has been in constant use without repairs for eighteen years, and is still giving the best results. One firm, now working two sets of apparatus, has never put one pound of fuel on the fire-places under the cylinders, since the heat of the reaction and that of the gas from the pyrites burners have proved fully sufficient for working the process. The following statement of the number of works using the apparatus is furnished the writer by Mr. John Hargreaves, of Widnes: England, five firms, using ten sets of apparatus; Ireland, one firm, using one; France, two firms, using two. The total amount of sulphate made by this process in 1888 was 43,080 tons.

CONDENSATION OF HYDROCHLORIC ACID.

Stoneware bottles, called "tourilles" or "bombonnes," and stone towers filled with coke are generally used for condensing the hydrochloric acid given off in the salt-cake process. Prof. G. Lunge has lately proposed a "plate column" for this purpose,† consisting of a stoneware tower filled with perforated plates of a peculiar design, so arranged as to secure complete and perfectly regular contact of the gas and water. This apparatus accomplishes the work of condensation far more perfectly than the coke tower, and is also very much less bulky. It may be used for any other purpose in which it is desired to bring liquids and gases into intimate contact.

THE BLACK-ASH PROCESS.

Barrel-shaped furnaces, revolving on a horizontal axis, have become general in alkali works, and in England have almost completely

* Sulphuric Acid and Alkali, vol. II, p. 138.

† Jour. Soc. Chem. Ind., 1887, p. 586.

replaced the old hand balling-furnace. Some manufacturers on the continent have hesitated to go to the expense of putting in mechanical furnaces on account of the doubtful future of the Leblanc process. The revolving furnaces do better and cheaper work and effect a greater saving in the very painful hand-labor of the black-ash process. Some very large furnaces have been built. One of these, according to Watson Smith, erected at the works of the Widnes Alkali Company, is 30 feet in length and 12 feet 6 inches in diameter. The capacity of this immense furnace is 25 tons of material per charge, and the amount of salt cake decomposed weekly about 400 tons. With this furnace, the consumption of coal is only 10 cwt. per ton of salt cake decomposed, while with ordinary furnaces 13 cwt. is required.

For calcining the black salt, obtained by boiling down the tank liquor from the lixiviation of the black ash, mechanical furnaces have within the past ten years generally replaced those worked by hand. Mactear's carbonating furnace, patented in 1876, was in use in 1878 in thirty works in England and France, and its use has largely extended since that time. A full account of modern mechanical salt-cake and carbonating furnaces is given by Mactear in the *Journal of the Society of Chemical Industry*, 1882, p. 26.*

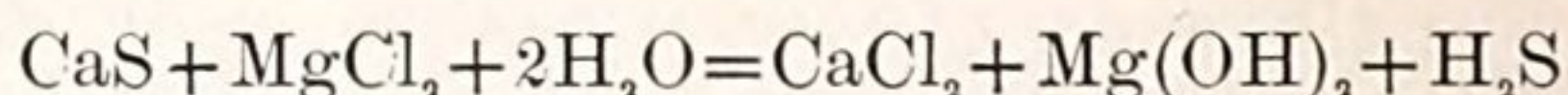
THE RECOVERY OF SULPHUR FROM TANK WASTE.

All the sulphur used in making acid for the alkali industry finally appears at the end of the process, chiefly as calcium sulphide, in the tank-waste. In England there are produced yearly 1,500,000 tons of waste, containing from 10 to 14 per cent. of sulphur. In the Widnes alkali district alone, the production of tank-waste amounts to over 1,000 tons per day. This material is not only useless, but is a source of intolerable nuisance on account of the odors which rise from it, and the pollution of the streams which it causes when allowed to collect near water courses. The effective disposal of this waste is a source of great expense. Many attempts have been made to extract the sulphur in a useful form, and at the same time to render the waste inoffensive. The methods of Schaffner and Mond depend upon the more or less complete oxidation of the waste, and the separation of sulphur from the resulting mixture of calcium sulphide and thiosulphate by treatment with hydrochloric acid. These processes have been used to some extent, especially in Germany and France, but accomplish the recovery of only about one-half the sulphur of the waste, and can not be said to have been commercially successful. The increased cost of hydrochloric acid has also of late years proved a serious obstacle to methods involving its use.

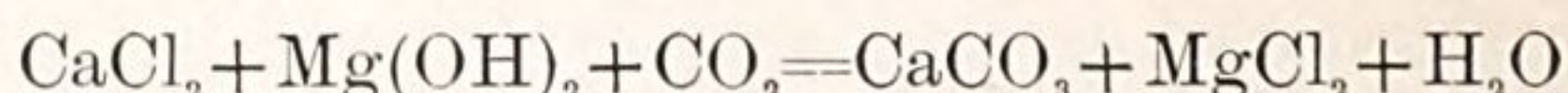
Schaffner & Helbig's process, introduced in 1878, was designed

*See also same journal, 1884, pp. 502, 607.

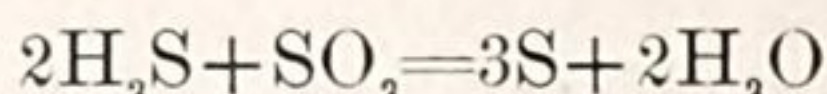
to recover all the sulphur of the waste in the form of hydrogen sulphide. This is accomplished by heating the waste in tanks with a solution of magnesium chloride, when the following reaction takes place:



By passing carbon dioxide into the resulting solution of calcium chloride containing magnesium hydroxide in suspension, magnesium chloride is regenerated, to be used over again, and calcium carbonate is precipitated in a form well adapted for use in the black-ash process.



The hydrogen sulphide given off in the first reaction is in part burned to sulphur dioxide, and this gas brought into contact with the remaining hydrogen sulphide in a solution of calcium chloride, the well known reaction



takes place, with separation of sulphur. The effect of the calcium chloride is to prevent the formation of polythionic acids, which would cause loss, and also to cause the sulphur to separate in a flocculent form, in which it settles readily and can easily be freed from the solution.

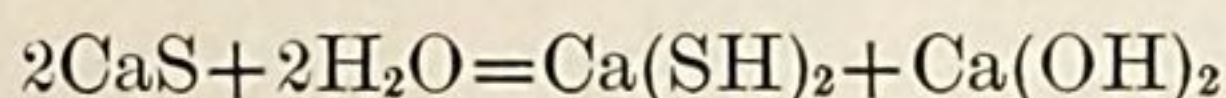
This process has been described in detail by Lunge,* and also by Commissioner Jenkins in the Reports on the Paris Exposition of 1878. It was introduced into England, and very fully experimented upon by the Chance Brothers at Oldbury, near Birmingham. The results of these tests† show that the waste may be completely decomposed, and the first two reactions made practically successful on a commercial scale. The production of free sulphur by the action of hydrogen sulphide and sulphur dioxide was, however, never satisfactorily carried out in practice, owing to the incompleteness of the reaction and consequent escape of one or both of these gases, the formation of polythionic acids, and finally the choking up of the pipes and flues by deposited sulphur. The hydrogen sulphide obtained was therefore generally burned in a special apparatus forming sulphur dioxide; this was used directly in acid-making. The process thus made it possible to use the sulphur of the pyrites over again many times in acid manufacture. It was expected that the "lime mud," or carbonate of lime precipitated in the second reaction of the process, would be useful in the black-ash process; this expectation was, however, only to a very limited extent fulfilled. The total saving in the process was estimated to be about equivalent

* Sulph. Acid and Alkali, vol. II, p. 689.

† Chance, Jour. Soc. Chem. Ind., 1882, p. 268; 1883, p. 292.

to 3*d.* per unit on the pyrites used in acid-making. A fall of this amount in the price of pyrites would therefore make the process unprofitable. Such a fall took place in 1884, owing to the breaking down of the combination of pyrites companies by which the price had previously been maintained. Attempts to use the Schaffner & Helbig process in England consequently ceased at about this period.

Weldon proposed long ago to reduce the amount of chloride necessary in the first reaction by employing Krausshaar's process of heating the waste with water under pressure. By this means the sulphide is converted into hydrosulphide and hydrate:



The calcium hydrate was to be filtered out, and the solution of hydrosulphide treated with magnesium chloride, of which only one equivalent would be required to two of hydrogen sulphide obtained. The magnesium hydrate, being free from the impurities of the tank waste, would be a salable product.

The decomposition of calcium sulphide by carbon dioxide has long been known, and was the subject of many experiments by Gossage and others more than 50 years ago, but owing to the irregularity of the composition and amount of hydrogen sulphide liberated this method of decomposition was never successfully practiced. In 1882 Opl proposed to pass carbon dioxide into the tank waste suspended in water, and to conduct the hydrogen sulphide given off into fresh waste, forming calcium hydrosulphide, which could then be treated with magnesium chloride, as in the Schaffner & Helbig process. In other words Opl proposed to accomplish by carbon dioxide the same result as Krausshaar by heating with water; namely, the concentration of the sulphur of the waste and separation of half the lime.

THE CHANCE SULPHUR RECOVERY PROCESS.

The success of this process has been announced during the past year.* It is in some respects an extension of that of Opl, and happily overcomes the practical difficulties which opposed the early experiments of Gossage and others who sought to accomplish the decomposition of tank waste by carbon dioxide. The remarkable success which has attended the practical tests of this process, and the rapidity with which it has been introduced into the leading alkali works of Europe, prove it to be one of the most important advances that have been made in modern times in the field of chemical industry. As the inventors received at the Paris Exposition the award of a grand prize for their discovery, a description of the process may not be superfluous.

The main difficulty which earlier experimenters had found in the

* Jour. Soc. Chem. Ind., 1888, p. 162.

decomposition of tank waste by carbonic acid from limekilns was the dilution and irregularity of the hydrogen sulphide obtained. Owing to the weakness of the gas it could not be burned to sulphur dioxide of sufficient strength for sulphuric-acid making, while the experience of the Schaffner & Helbig process proved the separation of sulphur from the gas to be a matter of great difficulty.

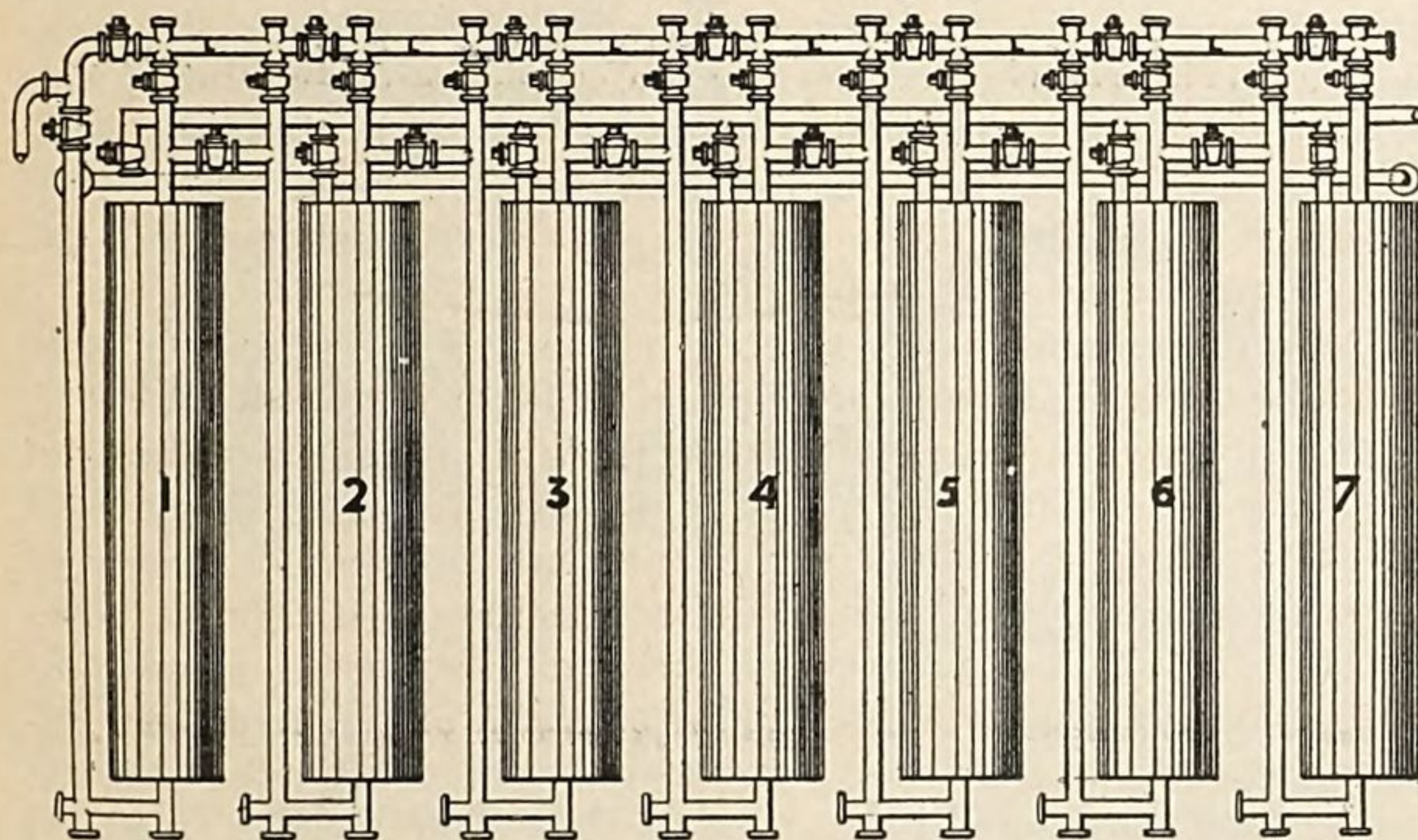
The Claus kiln (English patent, July 29, 1882), designed originally for the separation of sulphur from the gases obtained in the distillation of gas liquor, proved to be a very effective apparatus for obtaining sulphur from the sulphuretted hydrogen liberated from tank waste. By a very ingenious disposition of the decomposing vessels Mr. Chance succeeded in so conducting the process of decomposition of the waste by lime-kiln gases that very strong hydrogen sulphide was obtained, and it was found that by means of the Claus kiln this gas could be easily and cheaply converted into water and pure sulphur. The process, as at present carried on by Mr. Chance at Oldbury, near Birmingham, England, may be briefly described as follows:

The carbonic acid needed for the decomposition of the waste is obtained by burning Buckton limestone in suitable kilns provided with a cone at the base to throw the lime to the doors. The supply of air is regulated with care, and the gases obtained are therefore of nearly constant composition, containing from 29 to 32 per cent. carbon dioxide. Since caustic soda and bleaching powder are manufactured on a large scale at these works, the lime produced in the process finds a ready use. A part of the carbon dioxide is also used to carbonate the vat liquor in the manufacture of soda crystals. The hot carbonic acid is well washed and cooled by passing through towers about 12 feet high, filled with brick, through which a spray of water descends. The gas then passes to the carbonators in which the tank waste is to be treated. Before passing into the carbonators the carbonic acid is compressed by a 70 horse-power pump to a pressure of 45 pounds per square inch. One such pump can compress the gas needed to carbonate the waste produced in the manufacture of 300 tons of salt cake per week.

It is found that fresh waste is more easily decomposed than that which has lain on the heaps for a long time. At the Chance works, however, the yellow liquors which drain from the old heaps are mixed with fresh waste in a mechanical agitator, reducing the whole to the consistency of thin cream. The coarser parts are strained out by a sieve, and the thin waste raised by large plunger pumps to the top of the carbonators in which the decomposition by carbonic acid is to take place. The arrangement of the carbonators may be seen from the following diagram, taken from Mr. Chance's description of the process in the *Journal of the Society of Chemical Industry*, cited above.

The apparatus consists of a series of seven vertical iron cylinders, each about 9 feet in height and $2\frac{1}{2}$ feet in diameter. The compressed limekiln gas enters by the main and pipes L, L, L, by which it is conducted to the bottom of each carbonator. At the point of entrance into the cylinder a screw plug is placed, through which any obstruc-

Chance's Sulphur Recovery Process



tion in the delivery pipe may be removed by means of an iron rod. The carbonic acid in the gas passing into the first carbonator is absorbed by the waste, forming calcium carbonate, while the inert nitrogen mixed with the liberated hydrogen sulphide passes on into the next carbonator, in which the hydrogen sulphide is absorbed by the waste, forming soluble calcium hydrosulphide (sulphydrate), while the inert gases pass on through the series and escape. The carbonation of the first charge is continued until all the hydrogen sulphide is expelled (shown by the filtrate ceasing to blacken lead paper). This carbonator is then switched out of the series, emptied and refilled; thus each cylinder becomes in turn the first, second, third, etc., and finally last of the series. During the passage of the limekiln gases into each cylinder, the strength of the hydrogen sulphide liberated gradually increases from zero up to 30 per cent. When the latter point is reached, known by the gas burning freely in an ordinary Bunsen burner, the cylinder in question is connected with a gasometer of 30,000 cubic feet capacity, and the gas collected over water covered with tar oil as long as the required strength of the hydrogen sulphide is maintained.

The composition of the lime-kiln gases, and that of the liberated hydrogen sulphide, are determined every hour, the carbon dioxide

by absorption with caustic soda, the hydrogen sulphide, together with the small quantity of carbon dioxide contained in it, (about 2 per cent), also by absorption in caustic soda; in addition to this, an absolute determination of hydrogen sulphide is made once a day by titration of the acidified caustic soda solution of the gas with standard solution of iodine.

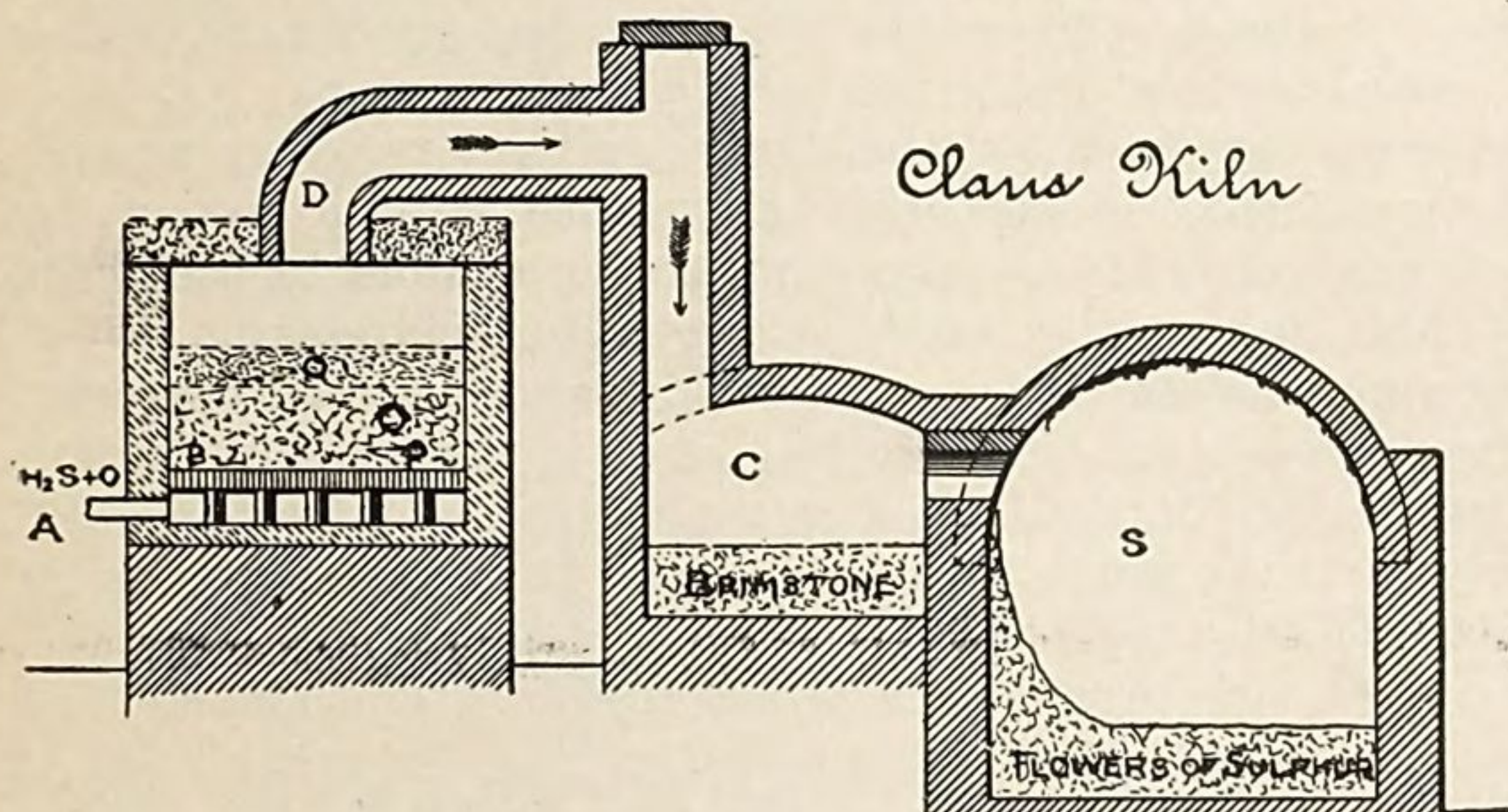
It was expected that the "carbonated mud," left in the carbonators after all the sulphur is expelled, would find employment as a substitute for limestone in the black-ash process. The value of the material for this purpose is increased by the considerable amount of soda present in it, which would thus be saved. Up to the present time, however, no very extensive use appears to have been made of the material. It is stated to be well adapted for cement making, and may eventually be employed for this purpose.

The hydrogen sulphide collected in the gasometer may be used either for the manufacture of sulphuric acid or of free sulphur. If, for the former purpose, the gas is burned with a regulated supply of compressed air from horizontal jets arranged about a special kiln like the tuyères of a blast furnace; the sulphur dioxide produced passes into ordinary lead chambers, and produces, with very low consumption of nitre, a remarkably pure, colorless acid, entirely free from arsenic and iron. Owing to the strength of the hydrogen sulphide burned and the consequent richness of the burner gas, the chamber space required is no greater than that usually employed when pyrites is burned. The heat of the burners is sufficient to work the Glover tower, also to concentrate a considerable amount of acid in pans placed above the burners. The acid produced is chiefly used for salt-cake; the sulphur contained thus makes a continuous circuit through acid, salt cake, tank waste, hydrogen sulphide, and back to acid again. A portion of the acid produced is also concentrated in glass retorts to 95 per cent., and sold for special purposes requiring a pure product.

The conversion of the hydrogen sulphide to free sulphur by means of the Claus kiln is a remarkably beautiful and interesting process. The following diagram shows the general construction of the apparatus.

The hydrogen sulphide, and the air necessary for its combustion to water and free sulphur, are separately measured in enormous gas meters, by which exact adjustment of the proportion of the gases is secured. About one part of air is required to four parts of hydrogen sulphide (containing 30 per cent. of pure hydrogen sulphide). The mixed gases then enter the kiln by the pipe A, passing up through the perforated bottom P, P, and then through a layer of anhydrous iron oxide, O, O, in lumps about the size of a walnut. By the action of the gases iron sulphide is probably formed and simultaneously oxidized, the sulphur dioxide produced reacting with the hydrogen

sulphide present to produce water and free sulphur. The reaction liberates enough heat to keep the iron oxide at dull redness. The steam and vapor of sulphur resulting from the reaction pass out of the kiln by the pipe D, and enter the small chamber C, in which about one-half of the sulphur is deposited in melted form, while the remainder, with the steam, passes on into the series of condensing cham-



bers S. In the first chamber perfectly dry flowers of sulphur, free from acid, are deposited, with a small amount of sulphur in the vitreous or semi-fused form. In the succeeding condensing chambers the flowers of sulphur formed are quite wet, and contain a considerable amount of acid. The material so obtained is purified by melting under water in a closed vessel by means of superheated steam; all the acid is thus extracted, and the fused sulphur is cast into rolls.

In actual practice at Oldbury, the construction of the kiln differs somewhat from that shown in the above drawing; it is found better to admit the gases at the top of the kiln, and allow the distillation to proceed in a downward direction. Two kilns are also connected with a single condensing chamber, C, and the latter is provided with a fireplace beneath for the purpose of melting the charge of refined sulphur, if this should become necessary.

The gases which pass out of the condensing chambers contain about 10 per cent. of sulphur in the form of dioxide and hydrogen sulphide. They are first passed through "scrubbing-towers" to remove the finely divided sulphur mechanically carried out of the chambers, and also that resulting from the continued reaction of the sulphurous gases upon each other; lastly the gases are passed through an iron oxide purifier, such as is generally used for coal gas, by which the remaining sulphur compounds are removed. The iron oxide in these purifiers is used until it contains sulphur to the amount of 30 per cent., then burned on shelf burners for sulphuric-acid making.

By the process above described 90 per cent. of the sulphur present in the form of waste may be recovered in the form of sulphuric acid or free sulphur. The cost of the process is extremely low, since from beginning to end, with the exception of the fuel needed to generate steam to drive the carbonic acid pumps, no fuel whatever is required. As all alkali makers who produce tank-waste use lime in large quantities for making caustic soda and bleaching powder, the carbonic acid needed for the Chance process is a waste product.

The great significance of the Chance sulphur recovery process is readily apparent. In case of the high price or high cost of transportation of pyrites, this process makes it possible to use the sulphur of the mineral over and over again for acid-making, thus decreasing the importation of pyrites to not more than 10 per cent. of the former amount. On the other hand, if the price of pyrites in England should be still further reduced, the process would be employed for the production of sulphur. It is estimated that over 100,000 tons of sulphur could be annually obtained by the treatment of the waste now produced in Great Britain. This amount is but little less than the total importation of Sicilian sulphur into the United States. It is quite possible, therefore, that our supply of sulphur for industrial purposes may eventually be chiefly derived from England instead of from Sicily.

Licenses to use the Chance process have been secured by more than twenty firms in Great Britain, all of which will probably be working early in the spring of 1890. At the following works, in addition to that of Chance Brothers, at Oldbury, sulphur is now being regularly manufactured by this process:

Sullivan & Co., Widnes.
Jarrow Chemical Company, South Shields.
A. G. Kurtz & Co., St. Helens.
Golding, Davis & Co., Widnes.
The Liver Alkali Company, Widnes.
Henry Baxter, St. Helens.
John Riley & Sons, Hapton, near Accrington.

In France, the St. Gobian Company has for some months past been successfully working the process at Sain-Fons, and is now considering the project of erecting a similar plant at another of its works. In Austria one firm has taken out a license, and will begin erecting the plant early in the present year.

The following interesting facts in regard to the extent to which the Chance-process sulphur is now being imported into the United States, are furnished by Mr. George Linder, of Boston.

As Mr. Chance was the only maker producing prior to Sept. 1, 1889, and the home trade took his production, very little came to the United States up to that date. In the last three months of the year considerable amounts were sent, amounting, for the year 1889, to about

1,000 tons. For the year 1890, 500 tons a month have been contracted for by Messrs. Linder & Meyer, and a further quantity will doubtless be imported by others. The sulphur from the Chance process is used largely for making wood-pulp by the sulphite process, as it burns without dross, thus saving much time, trouble, and expense. Its selling price is higher than that of Sicilian crude sulphur (3*d.*), the difference amounting to about \$6 per ton of 2,240 pounds; this, of course, puts the new sulphur out of the reach of acid-makers. As soon as it can be sold at a somewhat lower figure, large importations will follow. The question still to be solved is what quantity the home trade in England and the demand from Europe will absorb. When this is determined, it will be possible to foresee with some distinctness the extent of the probable importations into this country. The sulphur can be used to advantage in making gunpowder, as has been proved in factories where it has been tried; but manufacturers are timid about introducing a new article.

THE AMMONIA-SODA PROCESS.

A brief account of the present position of the Leblanc and ammonia-soda process has been given on page 571. The Solvay process, which is that chiefly used, has rapidly extended during the past ten years, and works have been established in France, Belgium, Germany, England, Russia, Austria, and the United States. A further account of this process will be given under the head of the exhibit of the Solvays at Paris.

The Schloesing process* is now being worked successfully by Bell Brothers, Middlesbrough, England. This differs from the Solvay process in that the production of ammonium bicarbonate, and the treatment of salt, take place as two distinct operations. Crystalline ammonium bicarbonate is prepared by the action of carbon dioxide upon ammonia. A large vertical cylinder is filled with the crystals so obtained, and a spray of brine evenly distributed over the mass. The ammonium salt is converted into bicarbonate of soda, while a solution of ammonium chloride is drawn off at the bottom. The bicarbonate is washed with water, and heated to convert it into soda ash. It is stated that the ash so obtained is far more dense and compact than that yielded by the Solvay process. Messrs. Bell Brothers are now producing 3,000 tons of alkali per year in the manner described. There is no present prospect, however, that the production by this process will be greatly extended.

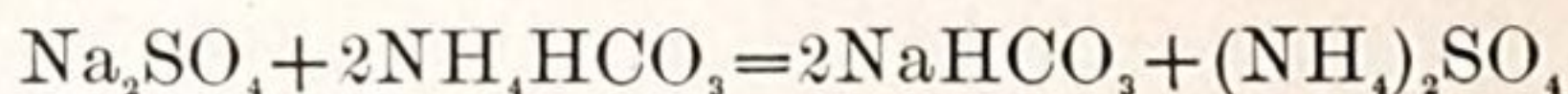
OTHER ALKALI PROCESSES.

Various other methods of making soda have from time to time been proposed, but none have assumed serious importance in prac-

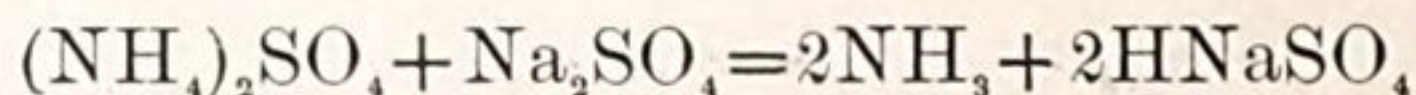
* English patent, 4025, March 30, 1889.

tice. The Cryolite process is used in the United States and to some extent in Copenhagen, but depends more for its success on the sulphate of alumina produced than upon the soda, and the total amount of alkali yielded by this process is not great.

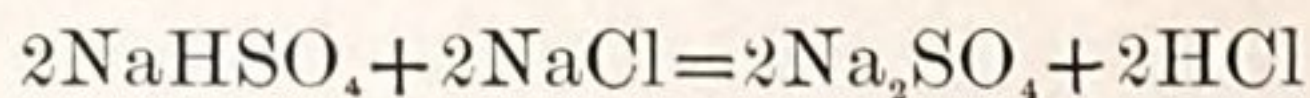
A very interesting process, which is virtually a combination of the Leblanc and ammonia-soda processes, was not long ago proposed in England by Carey, Gaskell & Hurter.* In this method, sodium sulphate is to be treated with ammonium bicarbonate in the same manner as the salt in the Solvay process, forming ammonium sulphate, and precipitating sodium bicarbonate.



The solution of ammonium sulphate is to be evaporated, and the residue heated by steam with sodium sulphate, by which ammonia is given off and sodium bisulphate left.

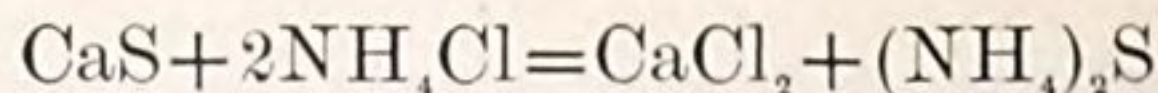


Thus the ammonia is regained; the sodium bisulphate is then simply heated with salt as in the second stage of the Leblanc process, forming hydrochloric acid, and the sodium sulphate required in the first and second reactions.



It will be seen at a glance that this process would produce sodium sulphate and soda, and also hydrochloric acid, from salt without the use of sulphuric acid. It was stated by the late Mr. Weldon to be practicable and promising. From information furnished the writer by the inventors, however, it appears that certain difficulties have been encountered which have prevented the process thus far from becoming a practical success. It is claimed by Blättner† that the decomposition of ammonium sulphate by heating with sodium sulphate is very imperfect, and that only about 70 per cent. of the ammonia is obtained. This is denied by the inventors, who claim to have secured complete decomposition.

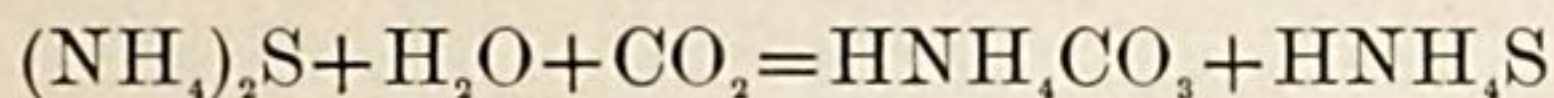
Parnell & Simpson's combined Leblanc and ammonia-soda process is now on trial on a manufacturing scale by the Lancashire Alkali and Sulphur Company, England. This is an ammonia-soda process, in which the sodium bicarbonate is obtained by treating brine and ammonium sulphide with limekiln gases; the resulting ammonium chloride is reconverted into sulphide by heating with Leblanc tank-waste. The waste and ammonium chloride are heated in vats by steam:



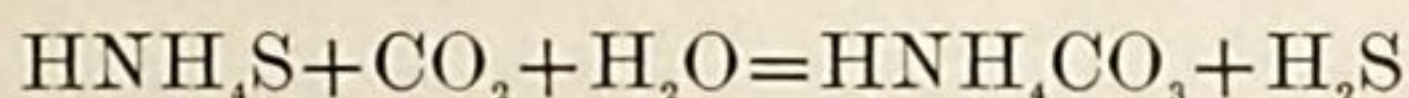
* Jour. Soc. Chem. Ind., 1884, p. 388.

† Dingler's Pol. J., 255, p. 253.

The ammonium sulphide distills off and is absorbed in strong brine. The carbonating operation takes place in two stages; in the first no hydrogen sulphide is given off, and the inert gases are allowed to escape:



In the second stage, complete conversion into bicarbonate takes place with the liberation of strong hydrogen sulphide:



The bicarbonate reacts with the salt present and produces sodium bicarbonate. The hydrogen sulphide is partly burned to sulphur dioxide; this is then made to act on the remaining hydrogen sulphide, producing sulphur, as in the Schaffner & Helbig process. The inventors claim to have made improvements by which the latter reaction can be successfully carried out.*

This process virtually makes a modified ammonia-soda process the means of recovering the sulphur from the Leblanc waste. Before the introduction of the Chance sulphur-recovery process, this method might have produced an important saving; it is difficult to see, however, in what respect it would be superior to the ammonia-soda process combined with an independent plant for the recovery of sulphur by Chance's method. The only saving which it would effect over the latter combination would be the cost of the lime ordinarily used to regenerate the ammonia.

An important obstacle in the Parnell & Simpson process is the presence of oxygen in the carbon dioxide from lime-kilns; this causes a considerable oxidation of the ammonium sulphide. The dilute state of the hydrogen sulphide evolved has also been a drawback, but might not be an obstacle to its conversion into sulphur in the Claus kiln.

The process is being worked by the inventors, with a production of about 40 tons of alkali per week, but is still in the experimental stage.

CHLORINE AND BLEACHING POWDER.

Almost the only use of the enormous quantity of hydrochloric acid which is produced in England is in the manufacture of bleaching powder. With the gradual decline of the Leblanc process, the production of bleach has to some extent diminished, and its price has been doubled within the last few years in order to compensate the Leblanc manufacturers for their loss in making soda. The fol-

* Jour. Soc. Chem. Ind., 1889, p. 11.

Following table shows the amount of bleaching powder produced in Great Britain since the time of the last Exposition:

	Long tons.		Long tons.
1878	105,044	1883	141,868
1879	115,290	1884	128,651
1880	131,606	1885	132,761
1881	135,826	1887	142,585
1882	135,170	1888	144,631

The price of bleaching powder which has lately prevailed is a serious burden to the great textile industries, and can scarcely be reduced as long as the world is entirely dependent upon the Leblanc process for its supply of this valuable product.

For the manufacture of chlorine from hydrochloric acid, the Weldon process, with regeneration of the manganese, has been for many years universally employed. At present, no manganese dioxide is used except to make up the mechanical losses in the Weldon process. Theoretically, this process should recover one-half the chlorine contained in the hydrochloric acid; but practically only about one-third is obtained; the rest goes to waste as calcium chloride. Many attempts have been made to devise a method for the more economical production of chlorine, especially of late years, since the value of hydrochloric acid is constantly increasing.

The Deacon process, which was first made known in 1870, is based upon the decomposition of hydrochloric acid by passing the gas, mixed with air, over heated balls of clay saturated with sulphate of copper; water is formed and chlorine set free. In practice, it is found that in well-managed works one-half the chlorine of the acid can thus be obtained in the free state. The remainder is not lost, but may be condensed in a dilute form, and again employed for the manufacture of chlorine. The Deacon process has also the advantage that it is applied to gaseous hydrochloric acid without the necessity of condensation. Many difficulties were encountered in the practical application of the process, the most important of which was the gradual cessation of the action of the copper salt after long-continued use. Within the past few years, chiefly owing to the efforts of Hurter, great improvements have taken place in the Deacon process. Pieces of burnt clay dipped in copper chloride are now used in effecting the combination of hydrochloric acid and air; these pieces of clay are used only once, and are thrown away when their action begins to diminish. Each hundred-weight of clay produces 1,000 to 1,200 cwt. of bleach. The process has recently made rapid progress, and is now in use at four large works in England, the combined output of which in 1888 was about 13,000 tons of bleaching powder. In these works, the hydrochloric acid which escapes decomposition is used for the manufacture of chlorine by the ordinary Weldon process. In this way, more than half of the chlorine con-

tained in the acid is obtained in the free state. The Deacon process has also been lately introduced into two works in France; at these establishments the undecomposed hydrochloric acid is condensed and sold. It is said that these two are the only chlorine works in the world at which the Weldon process is not employed.

THE WELDON-PECHINEY PROCESS.

A new method of manufacturing chlorine by the agency of magnesium chloride was patented by Weldon in 1882. The mechanical details of the process have been worked out with great care at the works of Mr. Pechiney, at Salindres, in the south of France. It has long been known that magnesium chloride when heated loses part of its chlorine. Weldon's invention consists in the addition of magnesia to a solution of magnesium chloride, producing an oxychloride, which is then intensely heated in a current of air in a peculiarly constructed furnace. All the chlorine is given off—about one-half in the free state, and the remainder in the form of hydrochloric acid. The residue left in the furnace consists of magnesia, which may be dissolved in the hydrochloric acid produced, forming magnesium oxychloride. This may again be employed for the manufacture of chlorine. It is evident that by this method all the chlorine contained in the hydrochloric acid may ultimately be recovered in the free state. Very serious mechanical difficulties have been encountered in working out the process. These have, however, been completely surmounted, and the Weldon-Pechiney process is now in successful operation, not only at Salindres, but also in England and Austria. At the Exposition Mr. Pechiney was awarded a grand prize for this invention, which, with the Chance sulphur-recovery process, were accounted the most notable advances in chemical industry there represented. In consequence of the important influence which this process is likely to exert upon the alkali and chlorine industries of the world, a brief description of the apparatus and methods employed at Salindres may not be inappropriate.

At Pechiney's works the process is employed in making chlorine from hydrochloric acid. Since the magnesia required is used over and over again, it is only necessary to add such quantity of magnesium salts as will compensate for the slight mechanical losses. This amount of magnesia is obtained in the form of chloride as a by-product of the extraction of salt from sea-water at Mr. Pechiney's factories in Camargue. The works at Salindres include a large Leblanc soda plant, and it is the hydrochloric acid obtained in this process that furnishes the crude material for that about to be described.

A solution of magnesium chloride is obtained by dissolving magnesia from the former operation in hydrochloric acid. This solution is then run into a large revolving vat provided with stirrers, shown in the following figure.

The pan A, containing the magnesium chloride solution, is caused to revolve slowly by means of a gearing shown in the drawing. The amount of dry magnesia required to form the oxychloride is then shoveled in gradually and thoroughly mixed with the chloride solu-

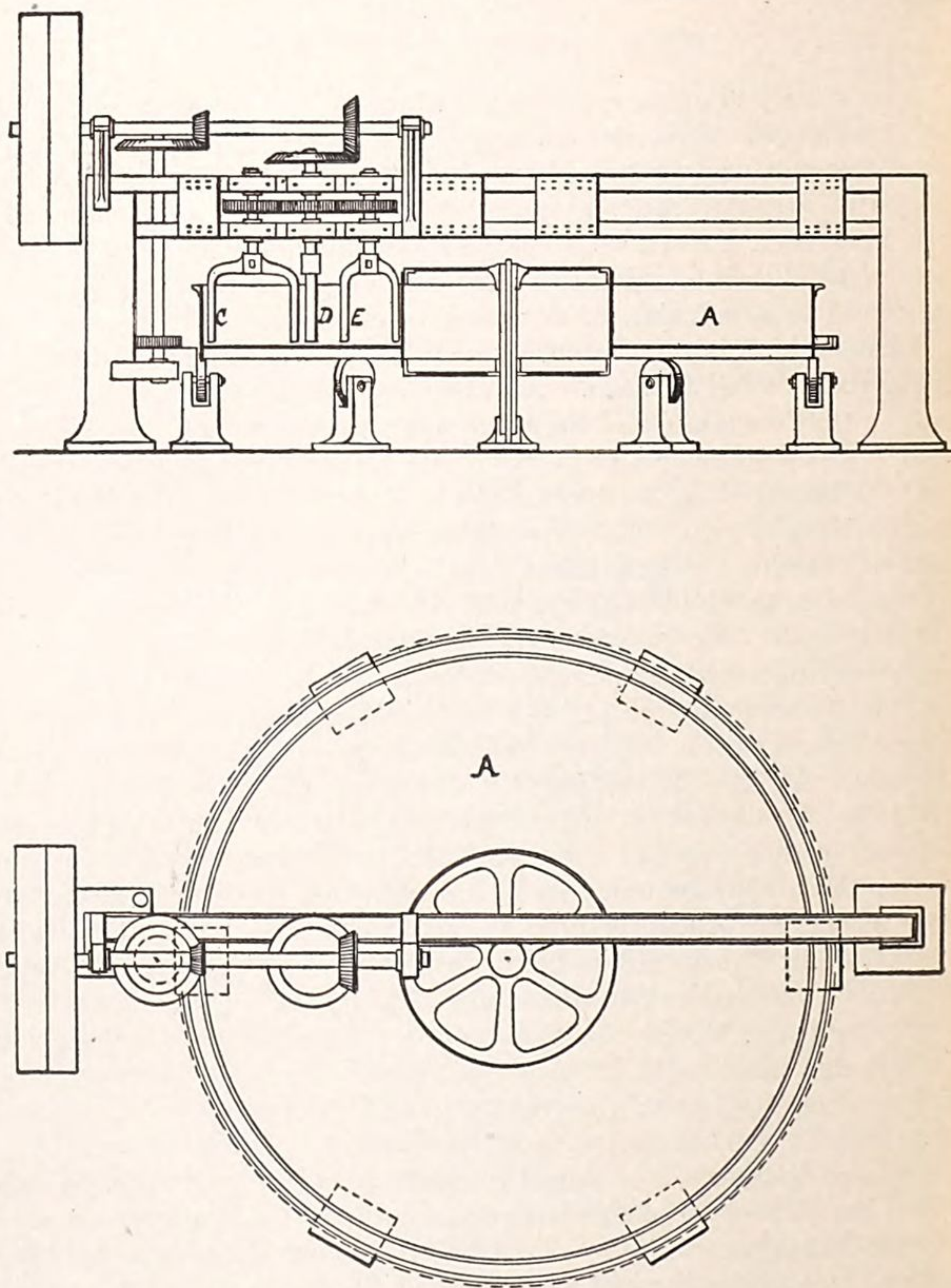


FIG. 5.

tion by means of stirrers C D E. The material soon becomes pasty, then quite solid, with violent evolution of heat, and is broken up into lumps by the stirrers. When cold the oxychloride appears per-

fectly hard and dry. It contains, however, about 40 per cent. of water. This amount must be considerably reduced before satisfactory treatment for chlorine can be effected. The oxychloride is first broken up into small lumps by rollers covered with conical projections, and is then partially dried in the ingenious apparatus shown in the next figure.

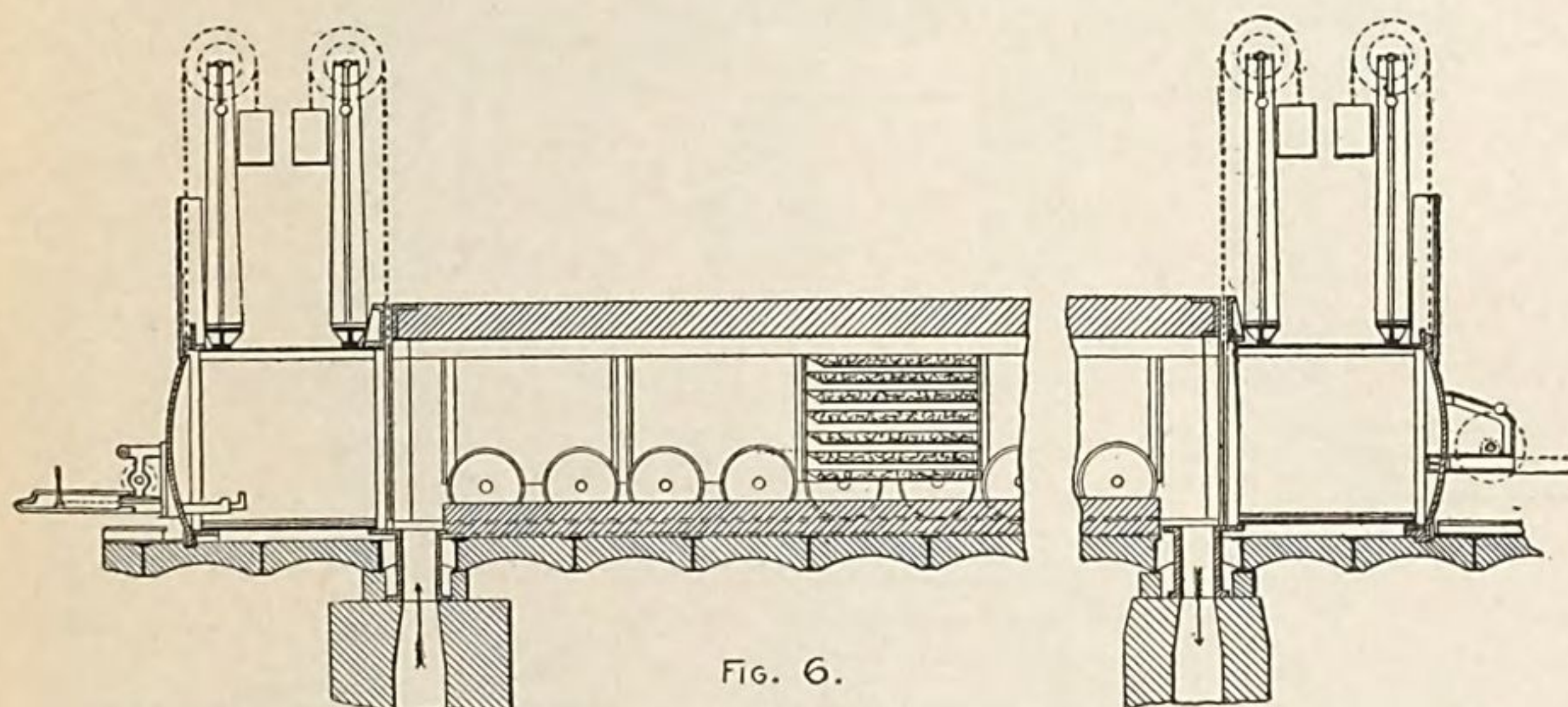


FIG. 6.

The oxychloride is spread upon shallow pans arranged one above another upon trucks, the spaces between the pans being so adjusted as to allow a free passage of air. A number of these trucks placed in a row are heated in a long horizontal cylinder by a current of hot air. During the drying a small amount of hydrochloric acid is given off, causing a loss of 5 per cent. of the chlorine contained in the oxychloride. After the drying the material contains about 21 per cent. of water. The dry oxychloride is now ready to be heated for the production of chlorine. This operation takes place in a form of furnace suggested by the late Walter Weldon and perfected by Mr. Pechiney. It is on the principle of a baker's oven—*i. e.*, the interior is heated for a certain time by the combustion of gas and air. The gas is then cut off and the charge introduced into the hot furnace. It is important that the temperature should be as high as possible and that the charge should be quickly heated, in order to secure a large yield of free chlorine. This is especially difficult of accomplishment because of the slowness with which the magnesium oxychloride conducts heat. Mr. Pechiney's latest form of furnace is shown in the following figure:

It consists of a series of extremely narrow fire-brick chambers, A A, with very thick walls, arranged in two rows back to back. The whole is incased in strong iron plates and mounted on trunnions, so that the furnace may be completely revolved. The chambers have flues at the top and bottom leading to openings at the sides. The furnace is heated by a peculiar movable regenerative burner, D. This is brought into contact with one side of the apparatus, and a strong

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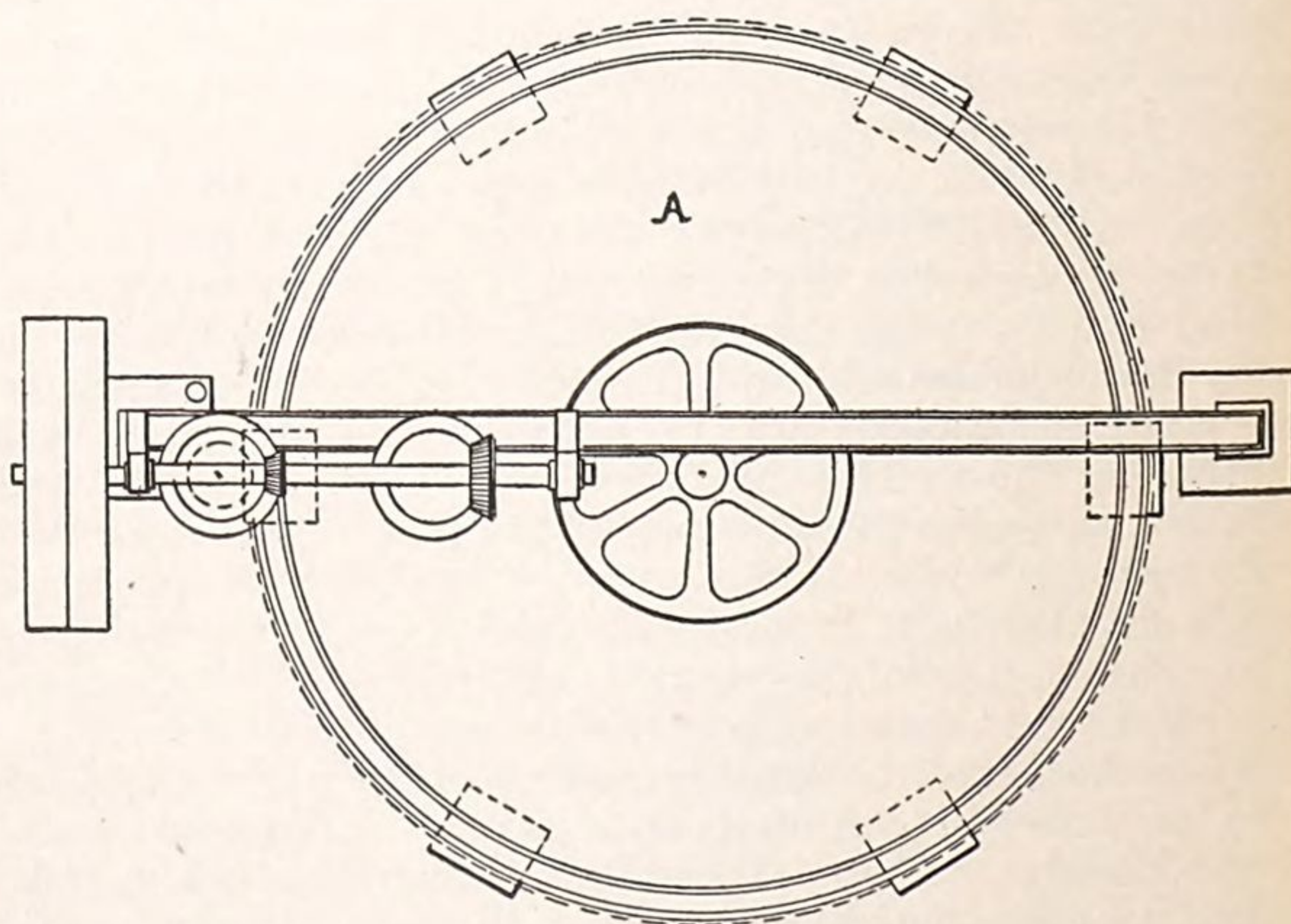
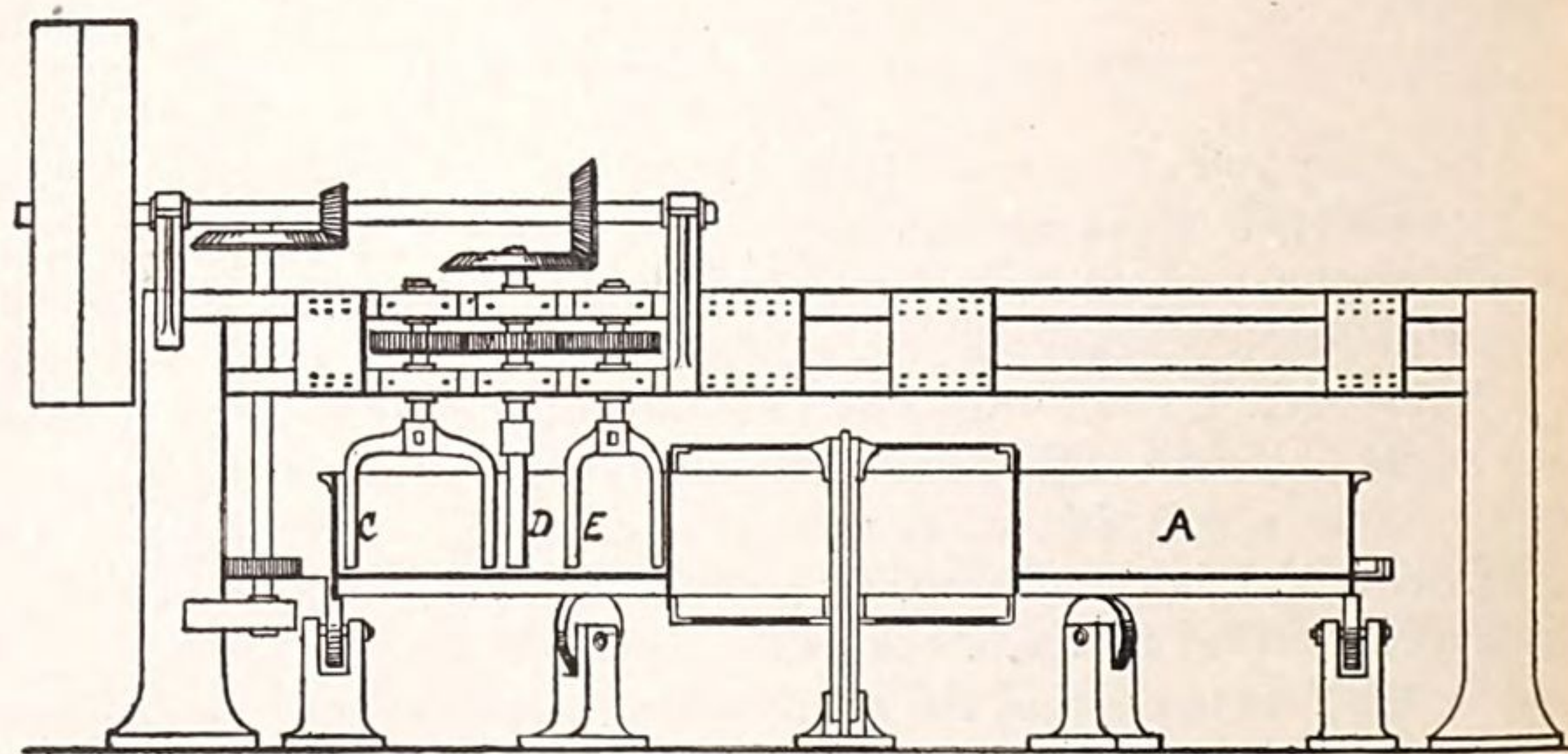
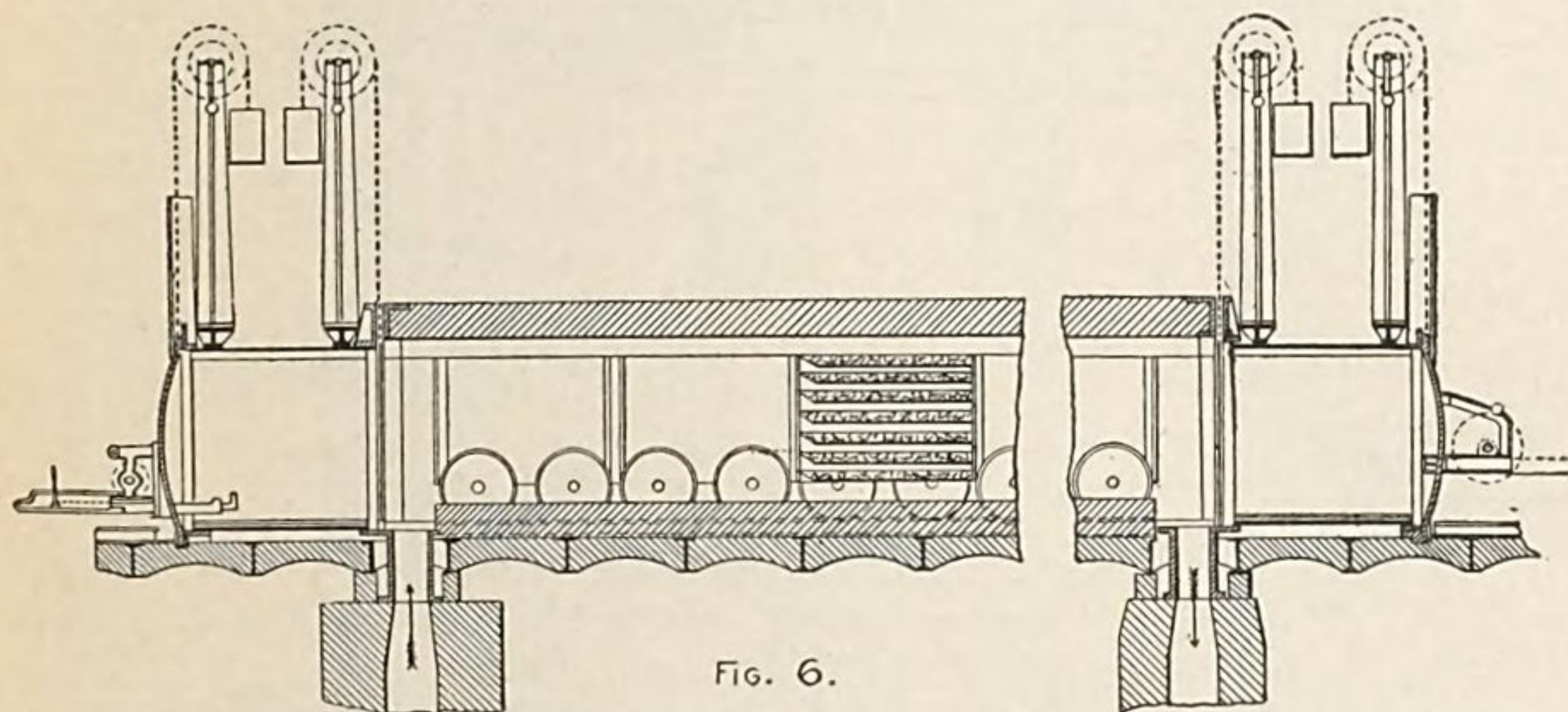


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current of fuel-gas and air is passed into the chambers. The gas passes through the flue B and enters the furnace by a number of small jets, C C. Air passes in through the passages *i u* and enters

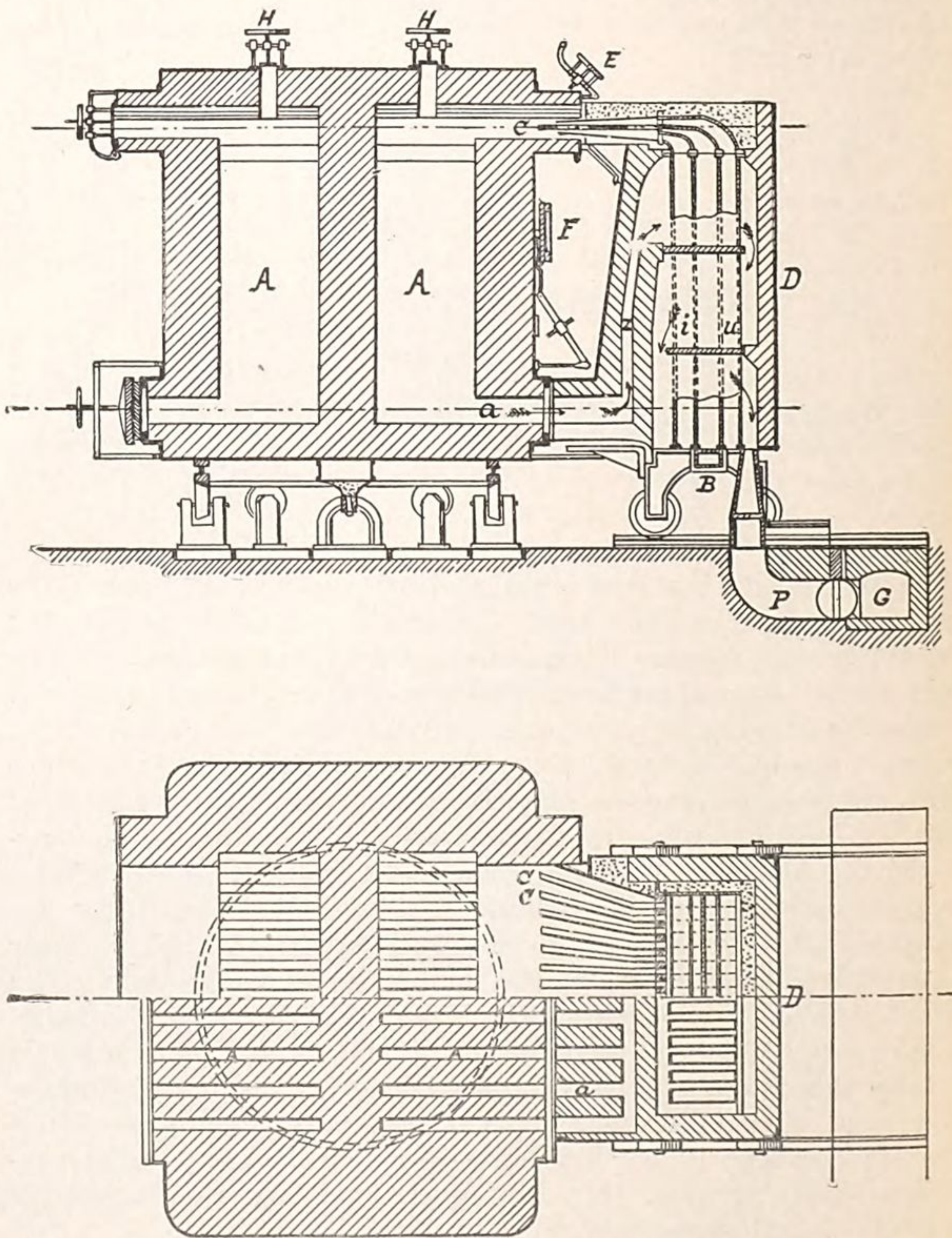


Fig. 7.

the combustion-chamber at the top by a broad flat tube extending over the whole width of the furnace. The hot gases from the combustion pass out of the chambers by the lower flues *a*, pass upward in the furnace by the flue *z*, and surrounding the flues by which the gas

and air enter, heat these intensely before passing out through the pipe P into the flue G, which conducts the hot gases to the furnace used for drying the oxychloride. When the whole interior of the furnace has been brought to a nearly white heat the current of gas is stopped, the burner drawn back, and the opening of the furnace closed by the doors E and F, which extend across the whole face of the apparatus. The furnace is then revolved, presenting the other half to the burner. This is then brought forward into contact, the current of gas and air started, and the second half of the furnace heated in the same way as the first. Meanwhile the apertures H in the top of the hot half of the furnace are opened, the charge of magnesium oxychloride introduced, and the flues *a* at the bottom connected with an exit-pipe for the escape of chlorine. Air is admitted through apertures in the door E. The decomposition of the oxychloride begins almost at once with liberation of chlorine and hydrochloric acid. These are drawn out of the apparatus by a constant aspiration of from 20 to 25 centimetres of mercury, maintained by a large vulcanite exhaust-pump. The mixture of hydrochloric acid and chlorine first traverses a tower containing a great number of horizontal glass tubes, through which a constant current of cold water is kept flowing; the gases are thus cooled, with the condensation of a large amount of hydrochloric acid in weak solution; they then pass through a series of stoneware bombonnes, and finally through an ordinary coke tower, where the last portion of hydrochloric acid is condensed. The chlorine passes on, and is used at Salindres chiefly for the manufacture of chlorates. The hydrochloric acid condensed in the tower and bombonnes is used to dissolve the magnesia extracted from the furnace at the end of the operation, forming a fresh quantity of magnesium chloride. It will be seen that the operation is continuous, one-half the furnace being heated while the other half is in operation; that the magnesia is used over and over again; and lastly, that the whole of the hydrochloric acid, with the exception of about 5 per cent. lost in drying the oxychloride, may finally be obtained in the free state. The process has been in operation on a manufacturing scale at Salindres for about two years. The apparatus at present employed produces about 760 kilogrammes of chlorine every 24 hours, with the consumption of 4,300 kilogrammes of coal. A somewhat larger apparatus of an improved design, figured in the drawing, has just been completed, and will soon be in operation. It is expected that this will produce 1,000 kilogrammes of chlorine per day.

The chlorine contained in the gases yielded by the process is, however, in an exceedingly dilute state—on the average, not over 5 per cent. by volume—and is, therefore, according to the experience of most manufacturers, too weak for the manufacture of good bleaching powder. Nevertheless, Dr. Hewitt and Professor Dewar, with

Mr. Weldon, deny that any difficulty will be found in this respect.* In order to use this dilute chlorine in bleaching-powder making, however, it will doubtless be necessary to employ some form of revolving chamber, such as has already been successfully employed for absorbing the residual chlorine in the common bleaching-powder chambers at the end of the operation. It must be acknowledged, therefore, that the problem of making bleaching powder by the aid of this process still remains to be solved, and that up to this time none of this product has in this way been made. When this shall have been accomplished the influence of the process upon the alkali industry will be far greater than at present, for it offers a simple method of making bleaching powder in connection with the manufacture of ammonia-soda.

The Weldon-Pechiney process in its earlier form is very completely described in a paper by Prof. James Dewar, published in the *Journal of the Society of Chemical Industry* for 1887, page 775.

For the manufacture of chlorates this process is an almost ideal one. It is being worked with this object not only at Salindres, but also at the factory of Messrs. Albright & Wilson, near Birmingham, where a plant of four times the capacity of that of Mr. Pechiney is in operation, producing 20 to 30 tons per week of potassium chlorate. The process has also been lately introduced at Sczackowa, Galicia, where it is used in connection with ammonia-soda works. The method there employed is the decomposition of the residual calcium chloride of the ammonia-soda process by magnesia and carbon dioxide, as in the second stage of the Schaffner & Helbig sulphur recovery process; the chlorine obtained is to be employed in the manufacture of chlorates. There can be little doubt that this process is destined to exert in the near future an important influence upon the alkali and chlorine industries. The plant is somewhat complicated, and costs about twice as much as one of the same capacity for the Weldon process; the consumption of fuel is also great. Nevertheless, the increasing cost of hydrochloric acid, and the consequent economy that results from obtaining practically the whole of the chlorine in the free state, have made it possible to work the process with profit. Especially important results are expected in case of the introduction of this industry into Stassfurt. It is well known that at that locality more than 200,000 tons per year of magnesium chloride, obtained as a by-product in the extraction of potash salts, are allowed to run to waste. By means of this process this waste product might be easily utilized for the manufacture of chlorine. It is estimated by Professor Dewar that the cost of a ton of chlorine at Stassfurt will not exceed £5 sterling; while its present cost in England by the Weldon process is not less than £13.

Another question of the utmost importance is the possibility of

* *Jour. Soc. Chem. Ind.*, 1887, pp. 789, 790; and 1885, p. 175.

utilizing this process for obtaining the chlorine which in the ammonia-soda process is now wholly lost as calcium chloride. As was mentioned above, it is quite possible to decompose this calcium chloride by means of magnesia and carbonic acid, forming magnesium chloride and precipitating calcium carbonate. This process has been worked out in detail and made a practical success by Mr. Chance in his experiments on the recovery of sulphur.* It would seem that in ammonia-soda works, where strong lime-kiln gases are made and pumped in large quantities, the conversion of calcium chloride into magnesium chloride should present no difficulty. If, however, magnesia can be substituted for lime in the regeneration of ammonia, magnesium chloride will be obtained directly, and will require nothing but evaporation of the solution to fit it for the Weldon-Pechiney process. This has already been made the subject of careful experiment by Weldon and Pechiney, and apparatus has been devised for the purpose.† Nevertheless it is not probable that manufacturers by the Solvay process will be disposed at present to cast aside apparatus that has cost so much time and money as the complicated plant for the regeneration of ammonia by lime, or to undertake costly experiments on the substitution of magnesia. It is certain that the use of magnesia for this purpose would demand a completely different system of apparatus from that at present employed.

The keynote of the whole question is simply this: Can the Weldon-Pechiney process be employed in bleaching-powder manufacture? In the study of this problem Mr. Pechiney and his assistants are now engaged. If the question is answered affirmatively, as there seems some reason to expect that it will be, it appears not improbable that the Weldon-Pechiney process, by furnishing a new and cheap supply of chlorine from the waste products of the ammonia-soda industry, will work the final overthrow of the Leblanc soda manufacture.

OTHER METHODS OF PRODUCING CHLORINE IN CONNECTION WITH AMMONIA-SODA.

Mr. Solvay is at present working on an experimental scale a process which has for its object the decomposition of the residual calcium chloride of the ammonia-soda process by means of silica. The calcium chloride is mixed with clay, formed into balls, and heated to a high temperature with superheated steam. According to Mr. Weldon, the hydrochloric acid obtained is exceedingly weak. It is concentrated by passing the gaseous product through a strong solution of calcium chloride. According to Hurter,‡ this process is not likely to attain any practical value, on account of the high tempera-

* Jour. Soc. Chem. Ind., 1883, p. 305.

† Ibid., 1886, p. 483.

‡ Jour. Soc. Chem. Ind., 1883, p. 105.

ture and large amount of steam required and the expense of concentrating the weak hydrochloric acid. Hurter says, in fact, that it might even be cheaper to put up lead chambers and decompose the calcium chloride by sulphuric acid.

Ludwig Mond, the head of the leading English ammonia-soda works, has patented the regeneration of ammonia by passing the ammonium chloride obtained in the process, in the state of vapor, over heated oxide of nickel. Nickel chloride is produced and ammonia set free. The nickel chloride is then decomposed by a current of superheated steam with re-formation of nickel oxide and liberation of hydrochloric acid. Mr. Mond has made private statements to the effect that this process will, in his opinion, certainly prove successful, and that no more than 2 or 3 years will be required to work out the details of its employment on a large scale.

FRANCE.

Compagnie d'Exploitation des Minéraux de Rio-Tinto, Marseilles.—These works were erected in 1884 for the purpose of introducing into France the Rio-Tinto pyrites for the manufacture of soda by the Leblanc process, and the extraction of copper, silver, and gold from the residues. This company manufactures sulphuric, hydrochloric, and nitric acids, sulphate of soda, soda-ash, bleaching powder, sulphates of copper and iron, and fertilizers, and obtains in addition the metals extracted from pyrites residue and the "purple ore" left after the treatment of the cinders by the Henderson process. Sulphate of soda is manufactured by Hargreaves' method. This is carried on by this company with a plant consisting of forty-eight pyrites furnaces and ten cylinders of a height of 4 metres and a diameter of 6 metres. The capacity of the whole plant is 30 tons of sulphate per day. The black-ash process is conducted in a revolving furnace of the ordinary pattern. Eight thousand kilogrammes of bleaching powder are manufactured daily by the Weldon process. The sulphuric acid plant consists of three lead chambers of 6,000 cubic metres capacity and platinum apparatus for concentration capable of yielding daily 5,000 kilogrammes of acid of 66° B. Nitric acid is manufactured with a daily consumption of 1,400 kilogrammes of nitrate of soda. These are the only works in France at which the extraction of copper and silver from pyrites residue is carried on. The cinders are roasted with salt on the hearths of large muffle furnaces. The lixiviation of the mass, extraction of silver by Claudet's process, and precipitation of cement copper by iron, are carried on in vats and labyrinths of wood and masonry distributed over a series of terraces occupying 1,800 square metres of surface. The company made a striking exhibit, consisting of a complete model of the works for treatment of pyrites residue, specimens of Rio-Tinto pyrites, acids, alkalies, salts, sulphate of copper,

bars of copper and silver obtained from pyrites, and specimens of purple ore. Large photographs of the works at Marseilles were also shown.

Société des Manufactures de Glaces et Produits Chimiques de Saint-Gobain, Chauny et Cirey.—The St. Gobain Company was founded in 1865, and at first consisted simply of soda works at Chauny. In 1872 the company was united with the *Société Perret Frères* at Lyons, and includes at present several works situated in different parts of northern France. The company produced in 1876 an amount of sulphuric acid equal to 61,000 tons, which in 1888 had increased to 117,000 tons. The manufacture of soda by the Leblanc process is carried on on a large scale. Mechanical furnaces are employed, of a total capacity of 45 tons per day. In 1888 the company decomposed about 35,000 tons of salt. The St. Gobain Company were the first in France to employ the Chance process for the regeneration of sulphur from alkali waste. This was introduced at Sain Fons a few months ago, and a second plant for the same process is about to be erected at Chauny. The representative of the company stated to the jury that the sulphur so produced could readily be sold at a price three times greater than that of the sulphur in the form of pyrites. The company manufacture also large amounts of nitric acid, bleaching powder, sulphate of iron, and fertilizers. The exhibit consisted of specimens of crystallized pyrites from San Bel, in France, containing as high as 55 per cent. sulphur; also inorganic acids, sulphate of iron and copper, soda ash and soda crystals, sulphur, regenerated by the Chance process, and two large slabs of pure selenium, each several kilogrammes in weight, which was extracted from pyrites at the works. The company also exhibited large masses of the San Bel pyrites in Class 41; superphosphates in Class 49; and in Class 19, fine products of the glass industry, including a polished plate of glass 13 by 25 feet in size. The latter is a decided advance over the plate which attracted great attention at the Exposition of 1878, the size of which was 11 by 17 feet.

Société Anonyme de Produits Chimiques, Établissement Malétra, Petit-Quevilly, near Rouen.—This establishment was founded in 1809, and includes not only the works near Rouen, but also factories at Lescure, St. Denis, and salt works at Arzew, in Algiers. At Petit-Quevilly nearly all the various products of the company are manufactured; at Lescure, principally acid, superphosphate and sulphate of iron; at St. Denis, soda crystals; finally, at Arzew, Algiers, 30,000 tons of salt are obtained yearly. Works have also been erected at Caen for the manufacture of sulphuric and nitric acid.

Sulphuric acid is manufactured from French pyrites, and used largely for the manufacture of sulphate of soda and fertilizers. Six platinum retorts are employed for the concentration of sulphuric acid, furnishing 360 carboys per day. The final concentration of

acid for the manufacture of explosives is carried on in iron retorts. Soda ash is made to the amount of 90 tons per day, and soda crystals to the amount of 16 tons. Among other interesting products manufactured by this company may be mentioned metallic cobalt and cobalt salts, made from mineral imported from New Caledonia. The production of cobalt compounds corresponds to about 20 tons of cobalt oxide annually. Another product made by this company is chloral hydrate, of which 20 tons per year are manufactured, the necessary chlorine being obtained by the Weldon process. The exhibit of the *Établissement Malétra* consisted of a fine display of acids, soda products, ores, oxide and salts of cobalt, pigments prepared from cobalt, and general chemicals.

Manufactures des Produits Chimiques du Nord, Établissement Kuhlmann, Lille.—This company showed general chemicals, acids, barium salts, “blanc fixe,” or baryta white, soda-ash, crystal and caustic soda, sulphur regenerated from tank waste, and bleaching powder.

Société Anonyme des Usines des Produits Chimiques d'Hautmont.—This society is chiefly occupied with the burning of zinc blende, and the manufacture of chemical products by means of the sulphuric acid thus obtained. The works are supplied with shelf-burners for pyrites, Glover and Gay-Lussac towers, and platinum stills for sulphuric acid. The Hargreaves process is used on a large scale for the manufacture of sulphate of soda; the cost of the plant was stated to be 460,000 francs. This company has also tested on a manufacturing scale the process for the manufacture of soda from sulphate, patented by Kayser, Young & Williams, of Buffalo, New York. In this process carbon monoxide and dioxide, from the combustion of coke, are passed over sulphate of soda contained in iron cylinders. The inventors claim that sodium carbonate is produced, with liberation of sulphur dioxide, which may be employed in the Hargreaves process. The company have been unsuccessful thus far in working this process, many serious difficulties having been encountered. According to Watson Smith, who tested the method in the laboratory, no carbonate is produced under any circumstances by the action of carbon monoxide and dioxide on sodium sulphate.

Mond's process and that of Schaffner were employed at these works up to 1875 for the regeneration of sulphur from tank-waste, but were then abandoned on account of the high cost of hydrochloric acid. The exhibit of the society consisted of a large model of the shelf-burners for blende; also a complete model of the Hargreaves plant, briquettes of salt and of sulphate of soda, soda crystals, superphosphates and general chemicals.

Société Anonyme des Verreries et Manufactures de Glaces d'Aniche, (Nord).—This company made a large exhibit of acids, salts, sulphate of soda, superphosphates, pyrites, pyrites residues, and *potée*

rouge, or purple ore, left after the extraction of copper from pyrites cinders.

Daguin et Cie., Paris.—The Société Daguin controls important deposits of rock salt at St. Nicolas-Varangeville, and produces annually over 80,000 tons of salt. The company also possesses an ammonia-soda works at La Madelaine, where, by a process of their own, about 12,000 tons of sodium carbonate are annually produced. The exhibit of the Société Daguin consisted of specimens of sodium carbonate, soda crystals, and bicarbonate of soda. Exhibits were also made in Class 41 of rock salt; Class 44, refined salt for agricultural and dairy purposes; and in Class 72 refined table salt of various grades.

Agobet et Cie., Arceuil (Seine), exhibited specimens of very pure bi-carbonate of soda manufactured by a peculiar process. It was stated to the jury that this firm are large manufacturers of wine from dry raisins. The carbon dioxide given off during the fermentation of the artificial must is conducted into chambers filled with bags of soda crystals hanging from the ceiling. Bicarbonate is thus gradually produced. On account of its purity, this product is largely employed for the production of pure carbonic acid for the manufacture of artificial mineral waters.

Pechiney et Cie., Salindres (Gard).—This was one of the most interesting exhibits in the chemical section of the Exposition, and consisted of pyrites from the neighborhood of Salindres; sea-salt, crude and refined, obtained at Pechiney's salt works in Camargue, and a number of products illustrating the preparation and purification of salt from sea-water. These consist of potassium chloride, magnesium chloride, the double chloride of potassium and magnesium, the mother liquors or bittern (containing chiefly magnesium chloride), magnesium sulphate, sodium sulphate, and "*sel mixte*," consisting of magnesium sulphate and salt. Mr. Pechiney is the originator of an ingenious method of obtaining sodium sulphate in an anhydrous form from the bittern of sea water. Balard's process consists in cooling down the liquid to a point considerably below freezing; at this temperature the magnesium sulphate present reacts upon the salt, forming sodium sulphate, which crystallizes out, leaving magnesium chloride in solution. The sulphate so obtained, however, contains ten molecules of water of crystallization, and the dehydration of this salt presents great difficulty. (The presence of water of crystallization in the natural sulphate of soda of Wyoming has, as is well known, been a great obstacle to its commercial employment.) Mr. Pechiney has found that if the hydrated sulphate is melted in its own water of crystallization at a temperature above 33° , and a certain quantity of the "*sel mixte*" added, the whole of the sodium sulphate separates in an anhydrous form. On account of its purity, the sulphate so obtained is particularly suitable for glass-making.

Mr. Pechiney exhibited also an interesting series of products illustrating the Weldon-Pechiney process; these consisted of magnesium oxychloride, crude and dry, and the anhydrous magnesia obtained at the end of the process. A striking series of specimens of different chlorates was also shown, to the preparation of which the Weldon-Pechiney process is especially adapted. Among these was one of sodium chlorate in fine cubical crystals. This product is largely in demand for use as an oxidizing agent in dyeing aniline black, for which purpose potassium chlorate is not sufficiently soluble. The preparation of sodium chlorate has heretofore presented many difficulties on account of its great solubility, and the difficulty of separating it by crystallization from the sodium chloride simultaneously produced. All the sodium chlorate of commerce has, therefore, hitherto been made from potassium chlorate. Mr. Pechiney has succeeded, however, in preparing the sodium salt without difficulty in the following way: chlorine is passed into milk of lime as usual, forming "crude chlorate liquor," which contains about five and a half equivalents of calcium chloride to one of calcium chlorate. This solution is evaporated to a density of 48° B., and cooled to about 10° C. At this point most of the chloride crystallizes out as $\text{CaCl}_2 + 2\text{H}_2\text{O}$; the liquor then contains only one and two-tenths equivalents of chloride to one of chlorate. It is then diluted with an equal bulk of water and a certain amount of lime added, and the whole heated to 80°. Calcium oxychloride is formed and filtered out. The solution then contains only one-third of one equivalent of chloride to one of chlorate. By the addition of sodium sulphate to this concentrated chlorate liquor, sodium chlorate is obtained with very little chloride, and may easily be purified by crystallization. Another important improvement in the manufacture of chlorates which Mr. Pechiney has introduced, is the substitution of magnesia for lime for the absorption of chlorine, thus forming magnesium chloride and chlorate. If one equivalent of potassium chloride be added to this, potassium chlorate crystallizes out, and a solution of magnesium chloride remains. This is then slightly evaporated and mixed with magnesia, and the resulting oxychloride treated as usual for chlorine. It will thus be seen that by the Weldon-Pechiney process potassium chlorate may be manufactured without consumption of chlorine, by the simple addition of the oxygen of the air to potassium chloride by the agency of magnesia.

The magnesium chloride obtained from the sea water is used to make up the losses of magnesia in the chlorine process, also for ice-machines and in removing organic matter from linen fiber.

The establishment of Pechiney et Cie. consists of salt works at Giraud, in Camargue, mines of pyrites at St. Julien and Soulier, (Alais), and chemical works at Salindres. The salt factories at Giraud cover over 2,000 hectares of surface, and produce 50,000 tons

of salt per year; one-third of this quantity is used at Salindres, and the rest sold and exported. Twelve hundred tons of potassium chloride are obtained from sea water, at a price which permits competition in France with the potassium chloride from Stassfurt. New works are being erected, which will increase the production of this salt to 5,000 tons*. At the factory at Salindres 16,000 tons of salt are used annually for the manufacture of soda by the Leblanc process. The hydrochloric acid produced is all employed in the manufacture of bleaching powder (Weldon process,) and of chlorates by the Weldon-Pechiney process, producing about 600 tons of chlorates yearly. One thousand tons of sulphur per year are regenerated from the alkali waste by oxidation and treatment with hydrochloric acid.

Another important industry with which the name of Mr. Pechiney is inseparably connected, is the manufacture of aluminium. It may safely be said that, until very recently, Mr. Pechiney was the only actual manufacturer of this metal in the world, and that very nearly the whole of the aluminium at present existing has been made at his works. The process employed by Mr. Pechiney is the classical one of Deville, consisting of the reduction of the double chloride of sodium and aluminium by means of metallic sodium. The exhibit of Mr. Pechiney included bars of aluminium and aluminium bronze, aluminium foil and wire, specimens of the double chloride, aluminium sulphate, precipitated alumina, and aluminate of soda.

Solvay et Cie.—The manufacture of soda, by the aid of ammonia and carbon dioxide was first attempted in England in 1837. Many subsequent efforts were made to employ this reaction, but serious difficulties were encountered, and it was not until 1863, when Mr. Solvay established his first works at Couillet, that the process was successfully worked. At the time of the Vienna Exposition of 1873 the Solvay Company showed that their annual production of soda had reached 4,500 tons, and that more than a hundred workmen were employed in their factories. At the present day the total production of the various works employing the Solvay process is probably not less than 500,000 tons. It may probably safely be said that at the present time more soda is manufactured by the Solvay process than by that of Leblanc. The introduction of the Solvay process has also reduced the price of soda by nearly 50 per cent.; thus effecting a saving of over \$20,000,000 annually.

The Société Solvay et Cie. was founded in 1863 for the application of the Solvay process. The company controls directly the works at present in operation in Belgium and France, and, in conjunction with other companies, those which have been established in England, Germany, Austria, Russia, and the United States. In addition, the society possesses large works in Belgium and France for the manu-

* For a complete description of the sea-water, salt, and potash industry at Salindres see Lunge, *Chem. Ind.*, 1883, p. 225, and *Jahresbericht*, 1888, p. 290.

facture of superphosphates and of ammonia from gas liquor, and one establishment devoted to the collection of tar and ammonia from the distillation of coal in the manufacture of coke for metallurgical purposes in coke ovens in the Semet-Solvay system. The following brief statement of the situation and magnitude of the various Solvay process works of the world will give some idea of the importance which this industry has attained.

BELGIUM.—The central bureau of the société is 19 rue du Prince Albert, Brussels. At the works at Couillet the first success of the process was attained. The factory was established in 1863, employs at present 210 workmen, and produces about 17,000 tons of soda annually.

FRANCE.—Works at Varangeville-Dombasle (Meurthe et Moselle). These works were founded in 1872. They are situated on the site of important salt deposits on the line of the railway between Paris and Strasburg. The annual production of these works is not less than 100,000 tons of soda, a large part of which is converted into secondary products—soda crystals, caustic soda, pure sodium carbonate and bicarbonate. For the manufacture of soda more than 700,000 cubic metres of brine are annually pumped from the salt springs of Flainval. The manufacture of hydrochloric acid from the residual calcium chloride of the process is also carried on at these works on an experimental scale, with a production of about 3 tons of chlorine per week.

ENGLAND.—Brunner, Mond & Co. (limited), Northwich and Sandbach (Cheshire). These works were founded in 1874, and produce at present over 120,000 tons of soda per year. They are, therefore, the largest ammonia-soda works in existence. The exhibit of this company in the English section included pure alkali made by the Solvay process, bleaching powder made by Mond's process by decomposing the residual ammonium chloride with nickel oxide, and ammonium sulphate from gas producers.*

Mr. Mond has proved that the ammonia contained in fuel gas can be easily and economically saved by the methods he has described, at a price not above half that of commercial ammonium sulphate. The process is especially applicable to large establishments, in which cheap fuel is employed. Over 150,000,000 tons of fuel are used annually in England, and if the ammonia produced from only one-tenth of this could be saved, the amount so obtained would be equal to all the ammonium compounds and nitrate of soda employed in the old world for fertilizing purposes. Brunner, Mond & Co. exhibited also pure bicarbonate of soda, produced by Mond & Jarmay's process. The bicarbonate obtained in the ammonia-soda process always contains some ammonia which can not be removed by

* Jour. Soc. Chem. Ind., 1889, p. 505.

washing, and on account of this the product is unsalable. Mond & Jarmay dissolve this impure bicarbonate in warm water, clarify the solution, and pass it in a constant stream through a series of cooling tanks. Pure crystalline bicarbonate is deposited and is afterward separated by a hydro-extractor from the mother-liquor. After repeated use for solution the ammonia is recovered from the liquor.

Another interesting product exhibited by this firm is the beautifully crystallized "sesquicarbonate of soda," made by the Watts & Richards process. This salt is composed of one equivalent of sodium carbonate, one of bicarbonate, and two of water, and has, therefore, the formula: $\text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3 \cdot 2\text{H}_2\text{O}$. It is prepared by heating sodium carbonate to such an extent as to deprive it of about one-third of its carbon dioxide, and dissolving the residue in water. On slowly cooling the solution with constant agitation the "sesquicarbonate" is separated in fine crystals. The great advantage of this salt is that it does not effloresce nor deliquesce, is readily soluble in water, and contains nearly twice as much alkali for a given weight as ordinary soda crystals.

GERMANY.—There are in Germany three works using the Solvay process, namely, at Wylhen, Baden; Bernburg, Anhalt; and at Saralbe, Alsace-Lorraine. These three works, established in 1880, 1883, and 1885, respectively, produce about 100,000 tons of soda per year.

RUSSIA.—There are in Russia two works using the Solvay process—one at Beresniki (Urals), producing 17,000 tons, and one at Lissitchansk in the south of Russia. These two establishments furnish sufficient soda to supply the whole Russian market.

AUSTRIA.—Works at Ebensee (Salzkammergut). These works were established in 1885, in conjunction with the well-known Aussig Company, under the direction of Dr. Max Schaffner. The production at present is about 11,000 tons per year.

AMERICA.—The Solvay Process Company at Geddes, near Syracuse, New York. Before the establishment of these works the whole American demand for soda, amounting to more than 180,000 tons per year, was supplied by importation, chiefly from England. The works at Syracuse began operations in 1884. Their production has steadily increased and now amounts to at least 60,000 tons, or one-third of the total American consumption of soda. Recent borings for salt undertaken by the company have resulted in the discovery of important deposits at Tully, a short distance south of Syracuse, sufficient to furnish an abundant supply of brine for the use of the works. A large plant for the manufacture of caustic soda has lately been added.

Production of ammonia.—It was prophesied, when the ammonia-soda process was first introduced, that the great demand for ammonia which the process would cause, and the consequent rise in price of this substance, would prevent the industry from ever assuming great

magnitude. This expectation has been proved to be erroneous. Nevertheless the cost of the ammonia required is an important item in the expense of the Solvay process. The Solvay Society has therefore made efforts to secure a regular supply of ammonia for use in the various works by collecting the by-products of the distillation of coal in coke ovens. This industry is carried on in works at Havre-Ville, Belgium, consisting of seventy-five coke ovens on the Semet-Solvay system.* Each oven produces about 1,000 tons of coke per annum, which is regularly used in the blast-furnaces of Longwy and the Grand Duchy of Luxemburg. The coal used contains 16 to 18 per cent. of volatile matter, and yields a quantity of ammonia equivalent to 5 to 6 kilogrammes of ammonium sulphate and 15 kilogrammes of tar for every ton distilled. The waste heat from the coke furnaces serves to keep in operation seven steam boilers of a total capacity of 500 horse-power. The ammoniacal liquor obtained from the coke ovens is for the most part concentrated by means of column stills to 15 or 18 per cent. and used in the ammonia-soda process.

The exhibit of the Solvay Company at Paris was displayed in a specially constructed stone pavilion of artistic design, situated just outside the industrial section and near the Porte Rapp. In the interior were shown an interesting model, more than 15 feet in length, of the works at Varangeville-Dombasle, a model of the Semet-Solvay coke oven, specimens of the various products, and large photographs of the several works using the Solvay process in different parts of the world. A further exhibit of the chief manufactured products of the Solvay Company was also displayed in the French chemical section, and in the English section by Brunner, Mond & Co.

In the foreign sections a number of important exhibits of acids and alkalies were made, among which may be mentioned that of the Société Anonyme des Manufactures de Glaces, Verres, et Vitres, etc., Brussels, which consisted of nitric, sulphuric, and hydrochloric acids and a great variety of chemical products. The Société Anonyme de Vedrin, St. Marc, Namur, exhibited a similar series of products. Exhibits of acids, salt, and alkalies were made by manufacturers from several other countries, including the French colonies and the Argentine Republic.

IV.—GENERAL CHEMICAL PRODUCTS, FINE CHEMICALS, ETC.

E. A. Billault, Paris.—This exhibit was one of the most beautiful features of the chemical section of the Exposition. Among the interesting objects shown was a fine series of salts of lithium, manufactured from amblygonite, a mine of which, not far from Paris, is in the possession of Mr. Billault. Magnificent transparent crystals

* *Revue Universelle des Mines*, XIII, 2d series, 1883.

of erythrite, salts of uranium, beryllium, rubidium, and ruthenium, large specimens of metallic lithium and calcium, a magnificent mass of iridescent bismuth more than one foot in diameter, very large fine crystals of the various platino cyanides, and many other rare and interesting products suitable for scientific collections, made up this remarkable display. Mr. Billault showed also metallic cylinders containing liquid methyl chloride, prepared according to the process of Professor Vincent. This substance, on account of the great cold produced by its evaporation, is now very largely used for producing local insensibility to pain in surgical operations.

L. Marquet de Vasselot, Paris, exhibited specimens of archil (orseille), and coloring matters extracted from this lichen. This was the only firm showing products of the once important *orceine* industry, which was so largely represented at the Exposition of 1878. The lichen is imported from Lower California; it contains a substance called erythrin, which is decomposed into erythrite, $C_4H_6(OH)(OH)_4$, and orcine, dihydroxytoluene, $C_6H_3(CH_3)(OH)_2$, on boiling with lime. The solution is freed from excess of lime by passing in carbon dioxide, evaporated, and the residue exhausted with benzine; this dissolves the orcine, leaving the erythrite, and yields crystallized orcine on evaporation. By spontaneous oxidation of orcine in presence of ammonia, *orceine*, a red coloring matter formerly much used as a dye, is obtained. This is now almost wholly replaced by coal-tar colors, and finds its chief application in the coloration of wines, confectionery, etc., for which it is well adapted on account of its non-poisonous character. The same lichens (*Rocella tinctoria*, *Rocella fuciformis*, etc.), yield the well-known coloring matter, litmus, by a process similar to that by which orceine is obtained; the chief difference between the two operations being, that in the case of litmus potash is added, and the oxidation is carried farther.

Mr. Marquet de Vasselot displayed magnificent crystalline masses and transparent crystals of erythrite, large masses of crystalline orcine, specimens of orceine, and a variety of fine products and pigments.

Brigonet et Naville, La Plaine St. Dennis (Seine), exhibited a fine series of inorganic and organic chemicals, including large crystalline masses of exalgine (methyl-acetanilide), also benzine, nitro-benzine, aniline, and a great variety of coal-tar derivatives, dyes, etc. This company also manufactures bichromates, chloroform, methyl chloride and other products.

Paul Moreau et Cie., St. André-lez-Lille (Nord), exhibited a variety of ethers, chloroform, absolute alcohol, tannin, and fine chemicals.

Poulenc Frères, Paris.—This exhibit resembled that of Mr. Billault in the beauty of its specimens, and in the excellent manner in which they were displayed. A great many rare products were shown, among which may be mentioned fine crystalline specimens

of croceo-cobaltic chloride and nitrate, prepared as described by Professor Gibbs; purpureo-cobaltic sulphate and chloride, prepared according to Fremy. This firm are also large manufacturers of boric acid, nickel and cobalt salts, salts of barium, strontium, and bismuth, potassium iodide and bromide.

A. Roques, Paris, exhibited fine specimens of crystallized iodine, iodoform, iodides, general chemicals, and fine bell-shaped masses of resublimed camphor.

Paul Rousseau et Cie., Paris, made a fine display of general chemical products, including a large series of pure and finely crystallized organic preparations, among which was shown a series illustrating the synthesis of indigo. A notable feature of this exhibit was the display of a number of very large and perfectly formed octahedral crystals of chrome alum, the largest more than 12 inches in diameter.

G. de Laire et Cie., Paris.—This firm, noticed at considerable length in the reports of the Exposition of 1878, exhibited again the products which attracted so much attention, illustrating the manufacture of artificial vanilline. This is prepared from *coniferine*, a glucoside obtained from the descending sap of the *Larix Europea*, a coniferous tree similar to the larch or tamarack, which grows in the forests of North Germany. When the trees are felled, the bark is removed and the exposed trunk scraped with a steel blade. The sap is then collected by means of a sponge, and from time to time squeezed out into a pail. The liquid is boiled, filtered, and evaporated to one-fifth of its volume; on cooling the coniferine separates in crystals. From a tree of average size 50 to 80 grammes of the product are obtained. Coniferine has the formula $C_{16}H_{22}O_8$. Under the influence of ferments it breaks up into glucose and coniferyl alcohol, $C_{10}H_{12}O_3$; the latter product yields vanilline, methyl-protocatechuic aldehyde, $C_6H_3(OCH_3)(OH)CHO$, on oxidation. In practice, the coniferine is oxidized directly by potassium permanganate at a low temperature. From the resulting products the vanilline is separated by extraction with ether, and purified by converting it into the bisulphite compound and decomposing this by sulphuric acid.

Eugenol, one of the constituents of oil of cloves, may also be converted into vanilline by oxidation. Mr. de Laire's patent process consists in the conversion of eugenol into acetyl-eugenol by the action of acetic anhydride, and oxidation of the product by means of potassium permanganate.

Another important source of vanilline is found in diseased or damaged vanilla beans, which are useless in their raw state on account of the disagreeable odor and flavor they possess. From these an abundant yield of pure crystallized vanilline may be obtained by a simple process.

Owing to the wide-spread prejudice which exists against the use in foods of the products of chemical processes, the introduction of

artificial vanilline has been slow, and the industry has not yet attained any considerable importance. Mr. de Laire's exhibit included beautiful specimens of crystallized vanilline, acetyl-eugenol, cinnamic acid, vanillic acid, anisic acid, and sucre vanilline, or sugar flavored with the artificial product and put up in packages for the use of confectioners.

Delval et Pascalis, Paris, exhibited large specimens of potassium cyanide, and fine crystalline masses of pure nickel sulphate, double sulphate of nickel and ammonium, and other products manufactured for use in electroplating.

Among the exhibitors of fine chemicals from foreign countries should be mentioned Alfred Lambotte, Brussels, who exhibited a series of tin salts obtained from tin scrap. The tin is removed by the action of dry chlorine gas, which has the property of attacking tin, but leaves the iron unaffected. Another method, largely employed in some works, is to heat the tin scrap repeatedly with a strong solution of caustic soda; by this means a 40 per cent. solution of nearly pure sodium stannate is finally obtained.

ALUM.

The principal methods by which alum is manufactured in Europe are the following:

(1) *From aluminous schist.*—This is a shaly rock, consisting principally of silicate of alumina, but containing also considerable quantities of iron pyrites and coal, which is mined largely in England and in Picardy, France. On prolonged exposure to the air the pyrites is oxidized to sulphate of iron and sulphuric acid; the latter decomposes the silicate of alumina, forming aluminium sulphate. The weathered material is leached with water, the sulphate of iron separated by crystallization, and the necessary quantity of potassium sulphate added to the aluminium sulphate solution remaining; by spontaneous evaporation alum is obtained. The production of alum from schist in Picardy is about 5,000 tons per year. In Germany alum is also largely made from alum earth, a material somewhat similar in composition to the aluminous schist.

(2) *From the alunite of Tolfa, Italy.*—This mineral consists chiefly of sulphate of alumina, but contains also about 10 per cent. of potash. It is largely mined at Tolfa, near Civita Vecchia, and is treated by simple calcination, lixiviation, and addition to the clear solution of the necessary quantity of potassium sulphate to convert the excess of aluminium sulphate into alum. Within the past few years this mineral has been largely imported into France in the calcined and powdered form, and is treated by the Compagnie de l'Alun Romain, at Rouen, in works connected with those of the Établissement Malétra.

(3) *From the alunite of Madriat (Puy-de-Dôme), France.*—Within a few years the alunite deposits of central France have been exten-

sively worked. The mineral occurs in rounded masses, distributed through beds of clay of the lower Tertiary formation. It varies in color from white to dark red, and resembles the Italian alunite in composition, consisting chiefly of sulphate of alumina, with 4 to 10 per cent. of potash, and considerable quantities of silica and oxide of iron. The mines at Madriat are controlled by Messrs. Pommier et Cie., at whose factory at Gennevilliers, near Paris, the mineral is treated for the manufacture of alum. The following account of the method employed at the Gennevilliers works is given by Mr. Pommier.* The alunite is pulverized under heavy cast-iron edge-runners, and calcined for 2 hours in a reverberatory furnace at a low red heat. A higher temperature is liable to cause some decomposition of the sulphate of alumina. From the furnace the calcined material is discharged into large iron pots, in which it is treated with hot sulphuric acid of a strength of 53° B. Five hundred and twenty-five kilogrammes of acid are employed for 400 kilogrammes of raw alunite. A vigorous action takes place, during which the material is constantly stirred with iron bars. The mass soon begins to solidify, and is then taken out by spades in the form of large lumps which are placed in iron wagons; these are then run into a furnace consisting of a low brick chamber heated to a low temperature by a fire-place at one end. The material is subjected for several hours to a gentle heat, during which time the reaction continues and becomes nearly complete. On removal from the furnace the stony masses of the crude product are piled up under a roof in the open air and left for several weeks. During this period the reaction of the sulphuric acid on the mineral is finally completed; the mass becomes gradually disintegrated and finally falls into powder. This is lastly laxiated with water, the solution clarified by decantation, evaporated, and allowed to crystallize. After all the alum has been deposited in the crystalline form, the excess of sulphate of alumina may be evaporated to dryness, or the equivalent amount of potassium sulphate may be added and a further quantity of alum thus obtained.

The manufacture of alum from alunite has the great advantage over that from schist, that the mineral contains already at least one-third of the potash necessary for the formation of alum.

J. E. Paul Marguerite Delarcharlonny, Urcel (Aisne), exhibited potash alum, ammonia alum, and sulphate of iron, manufactured from aluminous schist.

C. E. Noel, Noyon (Oise), exhibited alum and sulphate of alumina manufactured from the alunite of Tolfa.

Pommier et Cie. made a very fine exhibit of alum and sulphate of alumina manufactured from the alunite of Madriat; also dyeing chemicals of all kinds, metallic tin, and tin salts, indigo from Java, and kurpah lakes and extracts.

* Frémy's Encyc. Chimique, vol. v, sec. 1, part II, p. 183.

FERROCYANIDES AND FERRICYANIDES.

C. Arnold, St. Ouen-l'Aumone (Seine et Oise), exhibited potassium ferrocyanide (yellow prussiate of potash), carmine, and fine varnishes.

Ch. Dubois, Marseilles, already mentioned as the inventor of a process for the refining of sulphur, exhibited ferrocyanides extracted from the "spent oxide" of the gas works, of which 20 tons per day are treated at his works for sulphur and ferrocyanides. The process employed is not disclosed, but is probably not greatly different from that patented in Germany by Kuhnheim in 1884. In this process the gas-purifying residue is desulphurized and heated with lime; ammonia is given off and is condensed in the usual way. On leaching the residue and adding potassium chloride to the solution insoluble calcium-potassium ferrocyanide is thrown down. On boiling this with potassium carbonate potassium ferrocyanide is produced and obtained in crystalline form by evaporation.

Administration des Mines de Bouxwiller, Bouxwiller, Basse-Alsace, exhibited fine crystalline masses of potassium and sodium ferrocyanides and of potassium ferricyanide; also potassium cyanide and Prussian blue. These works, with the branch at Laneuveville, near Nancy, produce yearly about 800 tons of yellow prussiate. This is also chiefly obtained from gas-purifying residues; but at Bouxwiller 150 to 200 tons are obtained by the usual method from nitrogenous animal refuse. Of the ferrocyanide produced about 250 tons are annually transformed into ferricyanide by electrolysis. The process employed is probably that of Petri, of Alsace (English patent 7426, 1886). The apparatus consists of two cells containing the electrodes and separated by a porous partition. The cell of the negative electrode is filled with water, while that of the positive contains a solution of potassium ferrocyanide. By the action of the electric current the ferrocyanide is converted into ferricyanide, while in the cell of the negative electrode potassium hydroxide is formed with liberation of hydrogen. The process may be made continuous by causing the ferrocyanide solution and the water to flow continuously into one part of the cells, while the ferricyanide solution and potash lye flow off continuously.

IODINE AND ITS DERIVATIVES.

A very fine collective exhibit of iodine and derivatives extracted from varech (seaweed ashes) was made by the iodine manufacturers of Finisterre, France. Among those represented were A. Carof et Cie., H. Levasseur, Glaizot frères, De le Cluse Trewoedal frères, Le Gloahec fils, and G. Derrien. The exhibit included specimens of seaweed, varech (or kelp, the ashes of seaweed), crude and sub-

limed iodine, bromide and bromides, potassium sulphate and chloride, finely-crystallized mercuric iodide, and laminated lead iodide.

On account of the enormous production of iodine as a by-product in the extraction of nitrate of soda from the natural deposits of Chili, the manufacture from seaweed has been greatly reduced during the past few years. Not over 30,000 pounds of iodine are made each year in France; this is wholly used for home consumption. The production of this quantity is made possible only by a heavy duty on the Chilean product. In Scotland, two firms in the neighborhood of Glasgow are at present making iodine from kelp, and together produce about 100,000 pounds. The industry is maintained by a combination with the Chilean manufacturers. The amount produced in Glasgow is about one-sixth of the world's total consumption, the remainder coming from Chili. It is stated that the South American factories are capable of producing 2,600,000 pounds of iodine per year, but that the output has been limited by agreement to less than 500,000 pounds. In 1888 there were exported from Chili 200,000 pounds of iodine, and in 1889, 440,000 pounds.

PRODUCTS OF THE DISTILLATION OF WOOD.

C. Camus et Cie., Paris, made a fine exhibit of wood and charcoal, acetone, commercial and chemically pure methyl alcohol, various acetates, crude and refined, sugar of lead, also fine crystalline masses of chemically pure sugar of lead, crude and refined acetic acid, acetates of soda and lime, flake and powdered litharge.

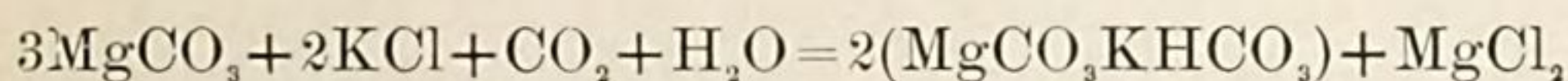
Kestner et Cie., Belleville (Belford), exhibited similar products, also light and heavy wood oils, wood tar, nitric acid, etc. Products of the distillation of wood were also shown by A. M. Theurier fils, Pierre-Benite (Rhône), in the Belgian section by the Usines des Moulins, Ghent, and also in the sections of several other foreign countries and colonies.

ALCOHOL AND POTASH SALTS.

Practically the whole of the world's supply of potassium salts is obtained from two sources; namely, the great deposits of Stassfurt, Saxony, and the residues from the extraction of sugar from the beet root. The latter industry might justly be included in the first, since the potash obtained from the beet-root residues is supplied to the soil in the form of crude potassium chloride imported from Stassfurt. In 1888 the Stassfurt mines produced over 125,000 tons of potassium chloride; this was exported to all parts of the world. It is estimated that 41.2 per cent. of this is used for the manufacture of potassium nitrate by treatment with Chili saltpeter; 20.4 per cent. as a fertilizing material in agriculture, 7.1 per cent. in the manufacture of less important compounds of potassium, the remainder being converted into potassium carbonate.

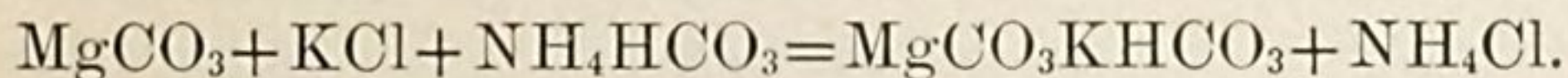
The manufacture of potassium carbonate from the Stassfurt chloride is now carried on almost exclusively by the Leblanc process, by methods almost identical with those employed in the manufacture of soda from salt. Not far from 30,000 tons a year of potash are at present manufactured, chiefly in Germany. Many attempts have been made to apply the methods of the ammonia-soda process to the manufacture of potash from chloride, but owing to the fact that potassium bicarbonate is much more soluble than sodium bicarbonate, the operation presents many difficulties. Among the methods that have been proposed to overcome this obstacle may be mentioned the following:

(1) *Engel's process*.—Carbon dioxide is passed into a solution of potassium chloride containing magnesium carbonate in suspension. The insoluble double carbonate of potassium and magnesium is precipitated with formation of magnesium chloride



The double carbonate is filtered out and decomposed by heating with water under pressure, forming potassium carbonate in solution and precipitating the magnesium carbonate. The magnesia and carbon dioxide needed are obtained by calcining magnesite. This process was tried on a large scale at Stassfurt by the Société Anonyme de Carbonate de Potasse, but was not successful, and has been abandoned. The magnesium chloride obtained is a useless product, and can not easily be reconverted into carbonate.

(2) *Borsche & Brünjes modification of the Engel process*.—Ammonia, as well as carbon dioxide, is passed into the solution of potassium chloride holding the magnesium carbonate in suspension. Ammonium chloride and potassium bicarbonate are formed. The latter is precipitated in combination with the magnesium carbonate present as an insoluble double carbonate,



It will be seen that this is simply the ammonia-soda process applied to potassium chloride with the introduction of magnesia to form an insoluble compound with the potassium bicarbonate.

The Vereinigte Chemische Fabriken zu Leopoldshall, Stassfurt, have erected a large plant for the purpose of testing this process on a commercial scale, and expect soon to produce 5,000 tons of potassium carbonate per year.

(3) *The Trimethylamine process*.—In the calcination of the residues from the "vinasses" of the beet-root sugar industry large amounts of trimethylamine and methyl chloride are obtained as by-products. Attempts have been made to use this trimethylamine in place of ammonia in the treatment of potassium chloride, since potassium bicarbonate is far less soluble in a solution of trimethy-

lamine chloride than in one of ammonium chloride. This process was worked for some time at St. Croix, near Lille, but has now been discontinued. It is stated that the Solvays have taken up the process again on an experimental scale at certain of their works, but no details in regard to their results have been made public.

POTASH FROM BEET-ROOT RESIDUES.

In the manufacture of sugar from beet-root a large amount of molasses is obtained, amounting in Europe to more than 250,000 tons yearly. This contains about 50 per cent. of sugar and from 5 to 6 per cent. of potash salts. Formerly all the molasses produced was subjected to fermentation, with the production of alcohol, and from the "vinasses" left after distilling off the alcohol potash was obtained in the form of carbonate by evaporation of the solution and calcination of the residue. This process is still carried on in France and Germany to a very large extent, with the production of about 15,000 tons of potash per year. The following statistics in regard to the quantity of molasses treated for alcohol and potash in France were furnished the writer by Mr. Durin, director of the Journal de la Distillerie Française:

Year.	Molasses treated.	Crude potash obtained.
	<i>Tons.</i>	<i>Tons.</i>
1886.....	189,266	20,819
1887.....	164,024	18,042
1888.....	222,775	24,505

The crude potash of the above table contains 32 to 35 per cent. of potassium carbonate.

Within a few years methods have been introduced (osmose and elution) which make it possible to obtain from the molasses most of the sugar contained in it in the crystallized form. Where these processes are used, fermentation of the molasses is not practiced, and the potassium salts are easily obtained in a comparatively pure state in the condition in which they exist in the beet root, namely, as nitrate, chloride, sulphate, and salts of organic acids. This material may advantageously be returned to the soil as a fertilizer. It is therefore evident that, with the extension of the use of these new processes for crystallizing sugar from molasses, the production of alcohol and potash from the beet-root residues will probably decrease.

POTASH FROM THE SUINT OF SHEEP-WOOL.

This industry is still carried on to some extent, especially in France and Germany. It was estimated in 1878, by Maumené, that a fleece of 4 kilogrammes in weight contains 600 grammes of suint, of which 200 grammes is potassium carbonate. According to this estimate, the

amount of wool annually produced at that time in France should yield 1,167 tons of potash. The potash is obtained in crude form by simple evaporation of the wool washings, and distillation of the residue in retorts. A few years ago the total quantity of potash produced from suint in Europe was estimated at 1,000 tons per year.

G. Claudon, Conflans-Charenton (Seine), exhibited different grades of potash, soda, and alcohol from beet-root residues; also a very interesting and complete series of organic products obtained by rectification from crude spirits. This series included propyl, butyl, isobutyl, amyl, and isoamyl alcohols, and a number of derivatives of these products, among which were many rare higher aldehydes and ethers. The total amount of molasses treated by this firm is 15,000 tons yearly, from which 4,500,000 litres of alcohol, and 1,020 tons of crude potash are obtained.

Veuve Ch. Décle et Cie., Rocourt, near St. Quentin (Aisne). The works of this firm are probably the largest of the kind in France. The annual production of alcohol is 13,000,000 litres, or 30 per cent. of the total amount produced from molasses in France; 3,500 tons of potassium carbonate and 1,200 tons of sodium carbonate are also obtained; the total consumption of molasses amounting to 44,000 tons per year. The exhibit of this firm included different grades of potash from 60 to 100 per cent., soda, potassium chloride, potassium sulphate, and alcohol of various qualities.

E. Porion, Wardrecques (Pas-de-Calais), exhibited similar products obtained by the treatment of beet-root molasses. The total amount of alcohol produced by this firm is stated at 5,000,000 litres, and that of potassium carbonate 2,500 tons.

Holden et fils, Croix (Nord), and P. Houzeau et Cie, Reims (Marne), exhibited also a fine series of products from the suint of sheep wool, including crude and refined potash, oils, and fats, for various purposes, such as the oiling of jute fiber, crude and fatty materials for enriching gas and the manufacture of soap.

OXYGEN.

The preparation of oxygen gas from atmospheric air by the agency of barium oxide was successfully accomplished many years ago by Boussingault, by the well-known method of heating the barium oxide to low redness in a current of air, forming barium dioxide, BaO_2 . At a higher temperature the barium dioxide is decomposed with liberation of oxygen and re-formation of barium oxide. It was found, however, that the efficiency of the material is very transient, and that the power of absorbing oxygen disappears almost completely after a few operations. Within a few years this method of obtaining oxygen has been carefully studied by Messrs. A. & L. Brin, of Paris. It was found that the deterioration of the baryta results

largely from impurities, especially carbon dioxide, contained in the air employed. The inventors found also that the absorption of oxygen by the baryta is greatly increased by pressure, and that the evolution of the gas takes place at a far lower temperature if a stronger vacuum be employed. By the application of these improvements, it was found possible to produce oxygen continuously, and to use the baryta an indefinite number of times. Apparatus for producing oxygen by this method on an industrial scale has been erected within the last two years in Paris and in London, and both works are now in successful operation. A description of the Brin oxygen producer was published some time ago in *Industries* (October 21, 1887). The apparatus, as figured and described in that article, consists of a number of horizontal cylinders heated in a furnace and connected together in sets of six. The method of working at the time of publication of the paper above quoted may be briefly described as follows: The retorts are filled with baryta prepared by igniting barium nitrate, each retort receiving about 125 pounds. The retorts are heated to 600°C ., or faint redness, and a current of air, previously purified by passing over quicklime and dry caustic soda, is passed over the baryta under a pressure of about 15 pounds to the square inch. After about two hours, during which time about 12,000 cubic feet of air have passed through the retorts, the gas issuing from them ceases to extinguish a flame, indicating that oxygen is no longer absorbed. The passage of air is now interrupted, and the temperature raised to 800°C . The pumps are then reversed, and the retorts exhausted to a pressure of about $1\frac{1}{2}$ inches of mercury. Oxygen is rapidly liberated, and is forced by the pumps into a large gas holder. As soon as the evolution of oxygen ceases the retorts are cooled by opening ventilators in the furnace to the proper temperature for reabsorption of oxygen. Since this description was first published important changes have taken place, both in the construction of the apparatus and in the method of working. The following drawing shows the construction at present employed, in vertical section and plan.

A A, etc., are vertical steel retorts 5 inches in diameter, closed at the bottom and projecting at the top a short distance above the top of the furnace. These are connected together in four sets of twelve, as shown in the plan. Air is forced in under pressure through the main B, and passes into the retorts by means of pipes reaching nearly to the bottom of each. Through the pipe C the oxygen gas is drawn off by the pumps. The method of working at present followed is to keep the retorts at a constant temperature of low redness, to force in air for a few minutes, then immediately to reverse the pumps and draw off the oxygen for an equal time. The operation is thus continuous, and no deterioration of the baryta takes place. On an average 5 cubic feet of oxygen per pound of baryta are obtained every 24 hours. It was stated to the writer by the manager of the English

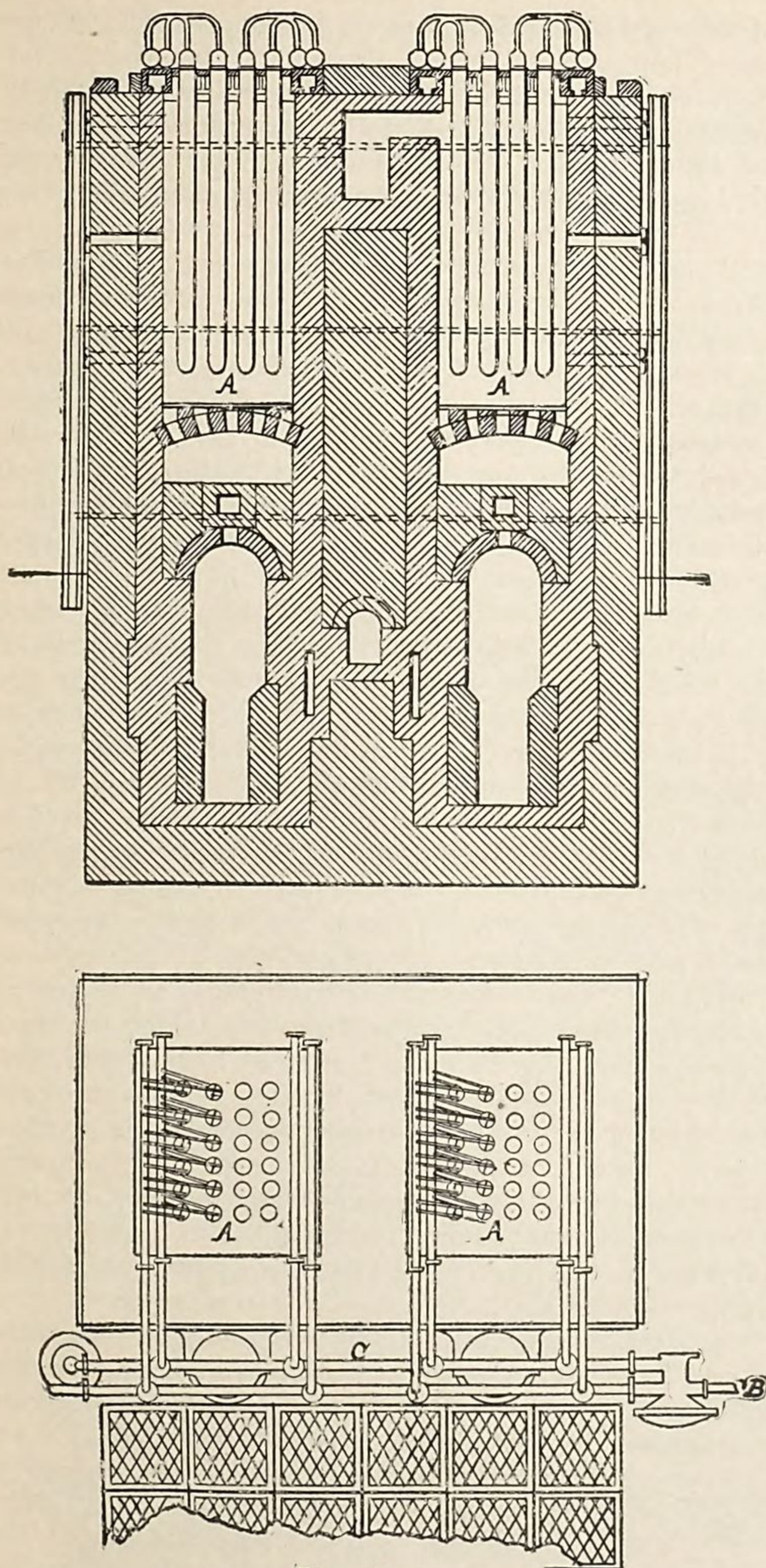


FIG. 8.

works (Horseferry Road, Westminster, London) that the cost of the oxygen does not exceed 5s. per thousand cubic feet. The producer above described yields 7,500 feet per day of 24 hours. It was stated that the cost of a plant for 10,000 cubic feet per day will not exceed £1,900 sterling. For sale and transport the oxygen produced is charged into mild steel cylinders at a pressure of 120 atmospheres.

The chief significance of this new industry is to be found in the possible application of oxygen on a large scale in various manufacturing processes. It has been found, for example, that the addition of oxygen in small quantities to coal-gas is a great aid in the process of purification. It is well known that coal-gas is chiefly purified in Europe by passing it over layers of oxide of iron. When this becomes saturated with sulphur it is exposed to the air, causing a separation of the sulphur in a free state and re-formation of iron oxide. This may be employed again in the purifiers and the process repeated until the oxide contains over 50 per cent. of sulphur, when it may be burned for the manufacture of sulphuric acid. It has been found that the introduction of 1 per cent. of oxygen into the gas before it enters the purifiers causes the process of revivification to proceed simultaneously with the absorption of sulphur, thus effecting a great economy in the handling of the iron oxide, and producing also a distinct increase in the illuminating power of the gas. The advantages gained by this use of oxygen have been clearly proved by the experiments of W. A. Valon, engineer of the Westgate Gas Works.* The Ramsgate Corporation Gas Works have an oxygen plant on the Brin system in regular and constant operation, the oxygen produced being used for the purification of coal gas.

It is stated, also, that a current of oxygen gas is a great aid in bleaching by means of bleaching powder, and causes an important saving in chlorine. It seems highly probable, moreover, that the intense heat which may be produced by the combustion of gaseous fuel with oxygen may find application in various metallurgical operations, as in the reduction of refractory ores. Up to the present time the chief use of the compressed oxygen has been in medicine and in the production of the oxy-hydrogen light. The Brin process is in operation at Glasgow, Manchester, and Birmingham, also at two or three points in Germany.

The Continental Oxygen Company (limited), of Westminster, London, and Passy, Paris, exhibited in the English and French sections cylinders of compressed oxygen gas, oxy-aërated water in pint and quart bottles, and oxy-aërated milk for medical use.

* Proceedings of the Gas Institute, June, 1888, and June, 1889, reprinted in Journal of Gas Lighting.

MISCELLANEOUS CHEMICAL PRODUCTS.

G. S. Chauvel, Paris, L'Evesque, Blouche & Triouleyre, Paris, and A. Porlier, Perreux (Seine), exhibited hydrogen peroxide and its applications in the bleaching of feathers, wool, silk, ivory, etc. The use of hydrogen peroxide as a bleaching agent is greatly extending, and the bleaching of woollen fabrics is now almost exclusively performed by means of this reagent. The fabrics are steeped in hydrogen peroxide and allowed to remain rolled up for some time, and then passed through a solution of sodium bisulphite. The manufacture of hydrogen peroxide is carried on by decomposing barium peroxide by an acid, generally hydrofluoric or phosphoric.

Mr. Cerckel, Paris, exhibited potassium chlorate made by the electric process of Messrs. H. Gall and A. de Montlaur. According to the English patent, this process consists in subjecting potassium chloride to a current of electricity in a trough divided into two compartments by a porous partition. The solution is kept at a temperature of 50° C. during the process. This industry has lately been established on a large scale at Vallorbe, Switzerland, where a water-power of 1,000 horse-power is employed. This firm exhibited also a number of pharmaceutical products, and salicylic acid and salicylate of soda made by Kolbe's process.

Doix, Mulaton & Wolf, Villeurbanne (Rhône,) exhibited specimens illustrating the manufacture of tartaric acid from the lees of wine, and also citric acid. This firm was the first to introduce the method of evaporation of tartaric acid solutions in a vacuum, which has been in use at these works for 15 years. The apparatus employed consists of large vacuum pans made of two hemispheres of lead or copper. (A similar system is largely used in the United States by one of the great baking-powder companies in the manufacture of pure cream of tartar.) The amount of tartaric acid annually produced in France is about 300 tons. The potash contained in the lees is seldom recovered, owing to the low price of the Stassfurt salts.

Mante, Légré et Cie., Marseilles, exhibited products similar to the above, consisting of wine lees, tartaric acid, cream of tartar, Rochelle salts, calcium tartrate, and sulphate of copper. The director of these works is Thaddée Gladysz, whose inventions in the manufacture of tartrates are well known. Gladysz's process for the treatment of lees is employed at these works, and is especially applicable to residues difficult of filtration. The dried residues are powdered and mixed with the mother liquors from a former operation. The mixture is treated with sulphur dioxide in a lead vat provided with a stirrer, until all bases are converted into bisulphites. The solution filtered from the solid material is heated by steam, until all the calcium tartrate contained in the solution is

precipitated in a pure crystalline condition. On cooling the solution potassium tartrate crystallizes out.

E. Beau, Alais (Gard), exhibited fine specimens of pure metallic antimony in large blocks, the surface showing the peculiar fern-like crystallization characteristic of the metal when pure, and which has given rise to the name "star antimony." There were also exhibited specimens of stibnite from the mines of Cassagnas, crocus of antimony, scorias, and antimonial alloys.

V.—EXPLOSIVES.

Modern explosive substances may be generally divided into four classes; (1) gunpowder containing nitrates, charcoal and sulphur; (2) gun-cotton, or nitro-cellulose; (3) explosives containing nitro-glycerine; (4) explosives containing other organic nitro compounds.

GUNPOWDER.

Among the more important novelties in gunpowder may be mentioned "chocolate powder," recently introduced in Germany, in the manufacture of which incompletely burned charcoal is used. This powder produces a considerably lower pressure than the ordinary powder, but communicates an equal velocity to the projectile. In the combustion of gunpowder, only about 41 per cent. of the material is converted into gas. Attempts have, therefore, often been made to substitute for saltpetre, nitrates of metals of lower atomic weight, or other salts richer in oxygen. Potassium chlorate has been often tried, but the manufacture of compounds containing it has proved extremely dangerous, and has led to numerous grave accidents, one of which, at Paris, on the 6th of October, 1870, caused the loss of thirteen lives. Chlorate still forms an ingredient, however, of certain modern blasting agents. Nitrate of soda, or Chili saltpetre, produces a powder which gives a greater volume of gas than that made with potassium nitrate, but has the disadvantage of being decidedly hygroscopic. Nitrate of magnesia is useless for the same reason. Ammonium nitrate is also hygroscopic, and on this account finds little use in the manufacture of gunpowder, but has lately found important application in the manufacture of another class of explosives.

GUN-COTTON.

The great advantage of this material is that when wet it is non-sensitive to friction or percussion, but in this condition may be exploded, as effectively as when dry, by means of a small dry primer of the same material. It offers special advantages in military and naval operations, and is now largely manufactured and transported in a moist state. For blasting purposes, gun-cotton is objectionable on account of the liberation of carbon monoxide which takes place

on its explosion, owing to the fact that the compound does not contain the oxygen requisite for its complete combustion. This may be overcome by the addition of oxidizing agents, such as saltpetre or barium nitrate, and such compounds are to some extent used. Gun-cotton has lately come largely into use in the form of "smokeless powder" for small arms. This material, sometimes called "Schulze powder," was invented twenty years ago by a Prussian artillery officer. It was originally composed of fragments of wood of regular size, which had been purified and imperfectly converted into nitro-cellulose, and impregnated with potassium chlorate. This powder has lately been greatly improved; its manufacture has been taken up in several countries, and its use is rapidly extending. A similar powder is made in England from gun-cotton, and has the great advantage of fouling the weapon but very slightly in use. The so-called "paper powder" made near Hamburg, and the "poudre B" or "Veille powder," now largely made in France, are probably substances of similar composition. The composition of the latter is, however, kept strictly secret by the French Government.

EXPLOSIVES CONTAINING NITRO-GLYCERINE.

For blasting purposes nitroglycerine in some form is the material almost universally used. In the pure state it is extremely sensitive to percussion and inconvenient to handle or transport. It is therefore found necessary to absorb it by some material which shall hold the nitroglycerine in a solid form and thus diminish the danger and inconvenience of its employment. There may be considered to be three classes of explosives containing nitroglycerine:

(1) Explosives containing nitroglycerine absorbed by an inert base, such as "kieselguhr" (infusorial silica) or magnesia. This class includes ordinary dynamite, which usually contains about 75 per cent. of nitroglycerine.

(2) Explosives containing nitroglycerine absorbed by some material which takes part in the explosion, such as sawdust or charcoal. Among the compounds of this character may be named "atlas powder," dualline," and "lithofracteur." *Carbo-dynamite*, lately introduced in England, consists of finely divided cork carbon saturated with nitroglycerine. This form of carbon is capable of taking up nine times its weight of the liquid, forming an explosive which is more powerful than nitroglycerine alone, since the latter contains an excess of oxygen above that needed for its own complete combustion. An additional advantage of this explosive is its great power of resisting moisture, a property which makes it especially useful for blasting in wet bore-holes.

(3) Explosives containing nitroglycerine gelatinized by the addition of gun-cotton. *Blasting gelatin*, a compound lately introduced

in England by Nobel, is of this nature, and is made by dissolving 7 to 8 parts of gun-cotton in 92 to 93 parts of nitroglycerine. It is a pale yellow elastic solid which is entirely unaffected by water, as shown by tests made of the material which had been immersed under water for several years. It is also far less liable than dynamite to accidental explosion. Since nitroglycerine contains an excess of oxygen, while gun-cotton requires an additional amount for its complete combustion, the reason of the greater efficiency of the combination is apparent. It has come rapidly into use, and has already largely replaced dynamite in Europe. Owing to its waterproof qualities it has been found especially valuable in submarine mining, and for this purpose has been adopted by the German, Austrian, and Italian Governments. It may also be mentioned that this agent is preferred to all other explosives for use with the pneumatic dynamite gun invented by Captain Zalinski of the United States Army.

EXPLOSIVES CONTAINING OTHER ORGANIC NITRO COMPOUNDS.

In 1873, Dr. H. Sprengel proposed to produce powerful explosives, whenever required for use, by mixing strong nitric acid with some aromatic nitro-product—such as nitrobenzene or picric acid. This was found inconvenient in practice, but the suggestion was made the basis of many different explosive mixtures which have lately been introduced. These consist of nitro-derivatives of the aromatic series mixed with ammonium nitrate, and are often spoken of collectively as the “Sprengel explosives.” *Roburite* consists of ammonium nitrate, dinitrobenzene, and chloronitrobenzene. *Bellite* is of a similar composition. *Rackarock* is a compound of nitrobenzene and potassium chlorate.

The Société Générale pour la Fabrication de la Dynamite, Paris, exhibited various products of nitroglycerine and dynamite manufacture, including the sulphuric and nitric acids regained from the residues of the process. The strong acid so obtained is concentrated to 66° B. and again employed, while the weak acid is used in the manufacture of sulphate of iron. The weak nitric acid obtained is used for cleaning metals to prepare them for electroplating and for the manufacture of ammonium nitrate. In the production of sulphuric acid pyrites from Chalemberto is employed, and copper is extracted from the residues by the Ravello electric process. This society also manufactures glycerine for explosives and for use in pharmacy. In addition to nitroglycerine and dynamite, the company also makes blasting gelatin and Nobel powder, a similar material containing nitroglycerine and gun-cotton, which is used as a smokeless powder for small arms. A rifle was shown from which two thousand charges of this powder had been successively fired. The amount of sulphuric acid manufactured by this society was stated to be 8,000 tons, and that of nitric acid 3,840 tons.

In the Belgian section the Compagnie Générale des Explosives Favier, Brussels, made a fine exhibit of materials and products of the manufacture of explosives. An especial feature of the display was a number of explosives of the Sprengel type, including compounds of ammonium nitrate with mono-nitro-naphthalene. This mixture, under the name of "Favier's safety explosive," has been licensed in England, and consists of 91.5 parts of ammonium nitrate and 8.5 of mono-nitro-naphthalene. The explosive is compressed in hollow cylinders and inclosed in waterproof wrappers. The interior cavity is filled with dynamite or gun-cotton. The company presented an interesting pamphlet, showing the results of a large number of practical tests of explosives of this class.

Fortis Explosive Association, Brussels, and the Société Anonyme de Dynamite de Matagne, Matagne la Grande, exhibited materials for the manufacture of explosives, with facsimiles of cartridges and cases.

ARTIFICIAL SILK.

An interesting and novel process was illustrated in the Mechanical Section of the Exposition, by which the so-called "artificial silk" is prepared from collodion, a solution of nitro-cellulose in ether and alcohol. The process is the invention of the Comte de Chardonnet, and was presented before the French Academy of Sciences in 1884.

The collodion is contained in a reservoir, and is forced out by air pressure through a number of tubes of glass with capillary orifices, issuing under the surface of cold water; the filaments are caught up and wound on a revolving bobbin. The operation takes place in a glass case, in which the drying of the filaments is accomplished by the aid of a volume of air used over and over again, and constantly freed from the ether and alcohol taken up by passing through a refrigerating tube. Loss of the solvents is thus prevented. The fibrous material collected on the bobbins is very lustrous and beautiful, closely resembling the finest silk, and may easily be dyed to any desired shade. A serious drawback to the practical application of the artificial fibre is its great inflammability. This may be overcome by immersing the skeins in dilute nitric acid, in which the fiber loses a large part of the nitric acid which it has taken up. Specimens of fabrics woven from the artificial silk were also shown. These appeared fully equal to true silk in luster and softness; it is not claimed, however, that the material is equal to silk in durability and resistance to wear.

No practical application of the process has as yet been made, and it does not appear probable that the artificial silk thus far produced will prove useful. The experiments of M. de Chardonnet have, however, shown that it is possible to obtain fibres of great fineness and beauty from textile materials in solution, and it is quite possi-

ble that in the event of the discovery of suitable solvents for silk, wool, etc., the process may have an important future.

VI.—GELATINE, GLUE, BONE-BLACK, AND PHOSPHORUS.

The modern process for the manufacture of gelatine from bones consists of the following operations:

(1) *Removal of fat.*—This is accomplished either by heating with water, or, as proposed in many modern patents, by extraction of the fatty matter, after thorough drying of the bones, by means of benzine or bisulphide of carbon.

(2) *Exhaustion of the bones by weak hydrochloric acid.*—This operation requires some days, and has the effect of dissolving out the mineral constituents of the bones almost completely, producing a solution of acid calcium phosphate, and leaving the bones in a semi-transparent, flexible condition. The solution may be evaporated and the residue used in the manufacture of fertilizers, or a certain amount of lime and calcium carbonate may be added, causing the precipitation of calcium phosphate in crystalline form. The Société Coignet, at Lyons, have adopted the method of precipitating the calcium from this solution by sulphuric acid, and using the solution again for the extraction of a fresh quantity of bones; after a number of operations, the liquid is evaporated with condensation of the hydrochloric acid given off, and the residue of acid calcium phosphate so obtained is used in the manufacture of phosphorus.

(3) *Extraction of the gelatine by water.*—This is generally accomplished by means of superheated steam, the operation being conducted in strong autoclaves. The solution of gelatine so obtained is evaporated in vacuum-pans to avoid injury by too great heat; the solution is then allowed to solidify, and the jelly cut into slices and dried upon a network in a free current of air. Glue is also largely made from scrap leather, the trimmings of fresh hides, and rabbit skins from which the fur has been removed for use in the manufacture of felt hats. Glue made from the trimmings of fresh hides and skins is said to be much preferred for certain purposes in which great strength is required, as in cabinet-making.

Coignet et Cie., Paris (works at Lyons), made a very complete exhibit of materials and products of the gelatine and phosphorus industries, consisting of glues and gelatines of various qualities, including the "gold label" and other grades of gelatine so much employed in the preparation of emulsions for dry-plate photography. A complete model of the works was also exhibited, and a model battery of phosphorus furnaces; unfortunately, however, the representatives of the company were unwilling to give any information in regard to the details of the processes employed. The methods of the manufacture of phosphorus are, as is well known, kept strictly secret by the manufacturers.

The following notes on the present state of the phosphorus industry were kindly furnished the writer by Dr. Readman, of Edinburgh:

Practically, all the phosphorus at present made is produced by Coignet et Cie., at Lyons, and Albright & Wilson, at Oldbury, England. A short time ago a firm in Bologne began the manufacture of phosphorus, but ceased operations a year or two later. A small amount of phosphorus is also made in Germany for use in the manufacture of saccharine; there are also one or two small makers in Russia. Albright & Wilson produce more than all the others together, and probably about three times the quantity made at the French works.

Phosphorus is made by the reduction of *glacial phosphoric acid*, not of calcium metaphosphate. This myth has been firmly held by the textbooks for a generation. The acid is made from one of the rich mineral phosphates, such as Canadian apatite; this is ground fine and treated with sulphuric acid in slight excess of the amount needed to combine with *all* the lime present. The mass is well agitated by blowing in steam. After a few hours the entire contents of the agitator are run out onto a filter, the bed of which is covered with ashes. The ashes retain the sparingly soluble gypsum, and allow the sherry-colored phosphoric acid solution to run through. This solution marks about 35° T. The sludge on the filter is carefully washed, and the filtrate evaporated to about 50° T., when a large deposit of gypsum separates and is removed by filtration. The clear liquor is then further concentrated to 100° T. (specific gravity 1.5), and should then be nearly free from lime. At this point the mass contains about 62 per cent. of P_2O_5 , with a small amount of sulphuric acid, and the oxides of iron, alumina, etc., present in the mineral phosphate treated. The reduction is accomplished by distillation with carbon as usually described. Dr. Readman has fully described the modern process of phosphorus manufacture in the article "Phosphorus," which he contributed to Thorpe's new Technical Chemical Dictionary, now in preparation. When this work appears it will be found to contain valuable information on this branch of industry. A new process for the manufacture of phosphorus has just been patented by Dr. Readman. This consists in the reduction of glacial phosphoric acid by the aid of carbon at the intense heat of the electric furnace, as in the reduction of aluminium by the Cowles process. The process is soon to be tried in England on a manufacturing scale.

Another new process, also proposed by Dr. Readman, consists in heating Charleston phosphate, sand, and carbon in graphite retorts to an intense heat in a wind furnace.—(This method is described in the J. Soc. Chem. Ind., 1890, p. 473.)

The exhibit of Coignet et Cie. included specimens of ordinary phosphorus, amorphous phosphorus, copper phosphide, calcined bones,

bone ash, and bone-black of various qualities for use in sugar refining and decolorizing.

The firm of Joudrain et Cie., Paris, made by far the most striking exhibit in this branch of chemical industry. Specimens of bone of various kinds—dried, degelatinized, calcined, and carbonized—were exhibited, all perfect in shape and admirably displayed. There were also shown specimens of torrefied and calcined horn, bone ash, superphosphates, and bone black of various grades for use in distilleries, sugar refining, decolorizing, and also in impalpable powder. This firm employs 200 workmen, consumes 8,000 tons of bones for the manufacture of glue, and 1,000 tons of bones and trimmings of hides for the manufacture of gelatine, producing 1,000 tons of glue and gelatine and 5,000 tons of bone fertilizers. Similar products were exhibited by Gigodot & Laprevote, Lyons; E. Hatton, Montreuil-sous-Bois (Seine); Jacquand Père et fils, Lyons; Morel & Georget, Aubervilliers (Seine) Totin Frères, Montreuil-sous-Bois (Seine), exhibited glues used in the manufacture of frames and in gilding, of which this firm produces nearly 1,800 tons. This amount is wholly made from rabbit skins from which the fur has been removed.

From the United States, Armour & Co., of Chicago, exhibited ground bone and horn prepared for the manufacture of glue; Le Page & Co., of Boston, exhibited their well-known liquid glue and cement; Christine Lugano, Kingston, New York, exhibited liquid glue; Macleish & Co., Buffalo, showed various qualities of gelatine; the Russia Cement Company, of Gloucester, Massachusetts, exhibited glue, gelatine, and isinglass, with specimens illustrating the various industrial applications of these substances; George Upton, Boston, made a fine display of various kinds of glue, liquid glue, isinglass, and gelatine, including fine grades of gelatine for culinary use; also sand-paper and garnet-paper. This firm has received orders from the French Government for a supply of garnet-paper similar to that shown.

In the Swiss section the Manufactures de Gelatine, Winterthur (Zurich), displayed the well-known Simeon's gelatine, especially prepared for photographic purposes, and probably more used than that of any other maker for the manufacture of photographic emulsions. Similar products were displayed also by a number of exhibitors in the English, Italian, Norwegian, and Russian sections.

VII.—SOAPS, GLYCERINE, AND STEARINE.

Marseilles has always been the chief seat of the soap industry in France, although a large amount of common soap and most of the fine toilet soaps are made at Paris. The soap made at Marseilles and in the north of Spain was originally made entirely from olive oil and natural alkali, containing enough potash to give to the soap a smoothness not found in that made from soda alone. This alkali

contained a considerable quantity of impurities, largely consisting of iron sulphide. The accumulation of this material in streaks and blotches during the soap-making produced the peculiar mottling or marbling effect characteristic of the "castile" soap. By the oxidation of the impurities the green color of the markings is changed to red at the surface, producing the well-known red crust of the genuine castile soap. If a greater amount of water than about 34 per cent. were present, the impurities would settle out and the characteristic markings would not appear. The marbling of the soap was therefore generally regarded as a guaranty of purity.

Marseilles has always possessed great advantages for soap manufacture, on account of the importance of the city as a seaport, the importation of grains from all parts of the world, and the very extensive manufacture of vegetable oils which is there carried on. The marbled castile soap was soon successfully imitated, both in Marseilles and in other parts of France, by the addition of a small amount of iron sulphate and ultramarine during the soap-making. The introduction of purer materials, and the gradual decrease of confidence in the marbling as a guaranty of purity, gradually led to the manufacture of large quantities of white castile soap at Marseilles. Palm oil is now imported in great quantities, and has largely replaced olive oil for soap-making. The soaps of Marseilles are, however, almost exclusively manufactured from oils of vegetable origin. In the north of France the manufacture of soap from animal oils, oleine from the stearic acid manufacture, and refuse fats of various kinds, has attained great magnitude.

Soap made from oleic acid was originally objectionable on account of its too great softness in warm weather; this difficulty has, however, been met by the addition of suitable amounts of tallow, or other animal fats. The Marseilles soap is still generally preferred for brightening colors, such as alizarine, in dyeing, since soap containing a large amount of alkali causes the reds to turn brown, and destroys the purity of the whites. There is little of importance to note in the way of progress in soap manufacture; the improvements which have been made consisting chiefly in the details of the machinery employed. An interesting paper by C. Alder Wright, on the chemistry of soap manufacture, was published in the Journal of the Society of Arts in May, 1885. The author of this paper has made two important inventions relating to soap manufacture, the first of which consists in forcing the melted soap through cooling tubes, from which it issues just soft enough to be easily pressed into bars of the required shape. By this method the labor of cooling the soap in molds, and cutting it into bars, is largely avoided.

Another interesting invention is the de-alkalization of soap by the addition of chloride or sulphate of ammonia. This is of course decomposed by the caustic alkali present, neutralizing the latter, and

setting the most of the ammonia free. The latter is chiefly volatilized, and the portion remaining in the soap is harmless, owing to the very mild caustic properties of ammonia.

STEARINE.

In the manufacture of stearine from fats the methods at present employed are the following:

(1) Saponification with a very small quantity of lime by superheated steam in copper or iron autoclaves. This method is very generally practiced in France, and has the advantage of yielding a very white, dry stearine, suitable for candle-making. The oleic acid obtained is nearly neutral, and is preferable to that obtained by other processes. This method gives also an almost perfect separation of the glycerine.

(2) Saponification by means of sulphuric acid, generally with subsequent distillation of the fatty acids. This process gives a somewhat larger yield of stearic acid; the candles made from it are, however, by no means so hard as those from the stearine of the first method. The oleic acid obtained is also less esteemed.

(3) Saponification by high-pressure steam alone. This method, originally patented by Tilghmann in the United States in 1854, consists in submitting the fat to the action of superheated steam, in strong autoclaves, at a temperature of 500° to 600° F. The process presents some difficulties, owing to the high pressure required, but is to some extent used both in America and in Europe. More frequently, however, 2 or 3 per cent. of lime is added, and the operation conducted at a lower pressure, as described above in method (1). A recent modification consists in replacing the lime by less than 1 per cent. of zinc oxide. This process was invented by Michaud frères, of Paris, and is extensively worked in the United States by the Continental Glycerine Company, of New York. The fat, with the addition of one-fourth to one-third its weight of water, and one-half of 1 per cent. of commercial zinc oxide, is subjected to the action of high-pressure steam in closed vessels. The action continues for 3 or 4 hours, and results in the decomposition of a large proportion of the fat into free fatty acids and glycerine.

The many applications which glycerine has found in recent years have led to the treatment of the spent lyes of the stearine industry for the separation of glycerine at a much larger number of works than formerly. Several manufacturers in France carry on the decomposition of fats for the sake of the glycerine, selling the stearic acid obtained to candle-makers.

CONVERSION OF OLEIC INTO PALMITIC ACID.

The oleic acid produced in enormous quantities in the manufacture of stearine is a product of comparatively little value, owing to

the softness and dark color of the soap which is made from it. A few years ago an interesting process was invented by Mr. Radisson, of Lyons, which consisted in the conversion of liquid oleic acid into hard crystalline palmitic acid, by long-continued heating with caustic potash or caustic soda, under heavy pressure. Potassium or sodium palmitate and acetate are produced; the former is decomposed by sulphuric acid, setting the palmitic acid free. The potassium or sodium acetate produced in the reaction is recovered. Accordingly to Carpenter,* this process was formerly practically worked at Marseilles in the large candle factory of Mr. Fournier, with the daily conversion of about 3 tons of oleic acid into palmitic acid. The inventor informs the writer that the process has not been worked since 1880, in consequence of the low price of tallow and high price of oleine which have prevailed during the past eight years. The cost of transforming liquid oleic into solid palmitic acid is about 20 francs per 100 kilogrammes. At present oleine costs 53 francs and tallow 58 francs per 100 kilogrammes; the industry is therefore unprofitable. At the time of the invention of the process the prices of oleine and tallow were 48 and 110 francs respectively. Mr. Radisson is at present engaged in the manufacture of oleomargarine, and claims to have succeeded in producing on a commercial scale the glycerides of the volatile fatty acids which give butter its peculiar character. The artificial product is thus made to approximate more closely to true butter, both in chemical character and flavor.

In the French section a great number of manufacturers of soaps and stearine displayed their products, among whom the following may be mentioned as the most important exhibitors:

J. Durand fils et Cie., Gentilly (Seine), purify tallow and manufacture tallow candles, stearine, stearine candles, and common soap. Twelve hundred tons of oleomargarine are manufactured at these works annually, and exported to foreign countries. Saponification is effected both by lime and sulphuric acid. In addition to the tallow employed, 1,500 tons of palm oil are annually treated for the manufacture of stearine.

E. Lacour, Petit-Quevilly (near Rouen), manufactures potash soaps from olive oil, palm oil, and oleic acid, chiefly for fulling cloth, cleansing wool, dressing cotton, etc. The soaps, which are much more expensive than those intended for domestic use, are made in different degrees of alkalinity, according to the purposes for which they are intended. This manufacturer produces also white soda soaps from olive oil or lard oil, yellow soda soap from palm oil, and common oleic acid soap; black soap, made from olive oil extracted from the oil-cake by bisulphide of carbon, and lubricating oils for oiling wool, were also displayed.

* Soap, Candles, and Glycerine, London, 1885.

P. Houzeau et Cie., Rheims (Marne), exhibited oils and potash extracted from the suint of sheep wool. Owing to a gradual change in the woolen industry at Rheims, the supply of washings from the cleansing of carded yarn and from the washing of wool has lately been greatly diminished, and the manufacture of potash from suint at this point is therefore decreasing in a marked degree. Houzeau et Cie. have therefore established a factory at Fourmies, where they at present make 480 tons per year of crude potash, and 540 tons of soap. The potash produced is in part used in the soap works, a considerable portion of it is refined and converted into caustic, the remainder is exported to England. This establishment produces also 150 tons yearly of oil extracted from wool washings and from the finishing of woolen goods. This material is used for currying leather, and also for the manufacture of soap. Houzeau et Cie. make a specialty of the manufacture of potash soaps from oleic acid for cleaning wool and yarn; potash soaps from oleic acid and olive oil for oiling and finishing woolen goods, and also commercial potash soap from linseed oil. The total amount of potash soaps made amounts to 700 tons per year. Soda soaps are also manufactured at these works from oleic acid and the green olive oil extracted from the pulp by carbon disulphide.

Baron fils, Marseilles, exhibited a statue and pedestal ingeniously carved out of white soap, plans of the works, and specimens of various products of the soap and candle manufacture. The production of the works was stated to be 8,000 tons of soap per year.

Charles Morel, Marseilles, exhibited hard soaps made from caustic soda, olive oil, palm oil, oil of sesame, peanut oil, and linseed oil. The total production of soap is not less than 12,000 tons per year. The method of manufacture followed at these works is thus described:

(1) *Preparation of the caustic lye.*—The crude soda is ground by means of a steam pulverizer of a new design. The ground alkali is mixed with slaked lime, and carried by wagons moving on a track to a set of 100 reservoirs of boiler plate, in which, by the addition of water, the caustic lye is produced. In the cellars below the factory are placed 31 large reservoirs into which the concentrated lyes are drawn off, and from which they are pumped up into vats and distributed to different portions of the works.

(2) *Boiling with the fatty material.*—Twenty boiling vats, measuring 11 feet in diameter and 11 feet in depth, are employed. A certain quantity of lye of a strength of from 10° to 11° B. is placed in each. Peanut oil, or palm-nut oil, is added in requisite quantity, and the whole brought to boiling until the oils are completely saponified. This operation requires generally from 30 to 40 hours.

(3) *Separation (relargage).*—A quantity of salt solution, of 26° to 27° strength, is added to the contents of the boiler, and thoroughly mixed in by stirring. The spent lye settles to the bottom of the ves-

sel, and is drawn off by a stopcock. A second addition of salt solution is made, and the contents of the vessel heated to boiling for 2 hours, after which the soap is allowed to separate and the solution drawn off.

(4) *Clear-boiling (cuisson)*.—Solid oils are added in requisite amounts, alternating with salted lye of 28° B., while the boiling is continued; four or five further additions of lye are made, and finally the “gras,” a fatty material obtained in the next operation, is introduced. One or two further additions of lye complete the operation. The completion of the boiling is recognized by the spent lye having a strength of 3° to 32° , and by the soap forming hard brittle lumps when squeezed between the fingers.

(5) *Liquidation*.—Weak lye of 12° is added, and the boiling continued for 4 or 5 hours. The spent lye is drawn off, and, on addition of water, the materials which have not been saponified settle to the bottom of the boiler; these impurities constitute the “gras,” which is added to the next lot in the former operation.

(6) *Cooling in frames*.—The contents of the boilers are left at rest for 30 to 40 hours. The scum which has risen to the surface is then removed, and the melted soap is raised by pumps and run into the cooling-frames. The cutting and stamping of the soap is performed by the usual methods, using specially designed machinery.

At these works the Chenailier system of concentration of glycerine from the spent lye is employed on a large scale.

A. de Milly, St. Denis (Seine): The name of de Milly is inseparably connected with the development of the stearic acid industry. In 1832 the founder of the firm established the first successful stearic acid works near the Barrière de l'Étoile at Paris, and manufactured there the “Bougies de l'Étoile,” or “star candles,” as candles made from stearic acid at the present day are often called. The method originally employed by Mr. de Milly for the saponification of fats was that of heating with a large amount of lime. This amount was afterward gradually diminished, until at present not more than 2 parts of lime for 100 of fat are employed. In 1839, Mr. de Milly made an important extension of the stearic acid industry in introducing the manufacture of soda soap from oleic acid. Between 1837 and 1849 de Milly's processes were extensively introduced into new works in Sweden, Germany, Austria, Spain, Italy, and Russia. In 1855 the method of saponification in autoclaves under heavy pressure, with the aid of a small amount of lime, was first employed, and was soon adopted by most of the leading manufacturers of the world. Experiments on the saponification of fats by means of sulphuric acid were also made at these works in 1866. After the death of Mr. de Milly, in 1876, the process for the saponification of oils and fats was still further perfected; and important improvements have been introduced within the past few years.

For the distillation of fatty acids, a peculiar still is employed at these works; this still is connected with a condenser, into which a spray of cold water is introduced under pressure. The effect of this spray is twofold; by its velocity the vapors are constantly aspirated from the still, and by its direct contact with the vapors their condensation is quickly effected. The still employed is stated to produce, in 24 hours, 7,000 to 8,000 kilogrammes of white fatty acids ready for treatment in the hydraulic presses.

An important improvement has also been made at these works over the old form of hydraulic press for the separation of the solid fatty acids from the oleine. In the old form of apparatus the hollow plates employed were of considerable weight and bulk; their interior channels were also easily obstructed, necessitating frequent stoppage and removal of the plates for the purpose of cleaning them. At these works these bulky hollow plates have been replaced by plates of sheet-steel of only 15 millimetres thickness. Hair-cloth tissue, made of very light material, is employed, with the effect of increasing the number of plates contained in the press from twenty-eight to fifty-five, producing from a single charge fifty-four blocks of stearic acid instead of twenty-seven. Such a press yields 25,000 kilogrammes of stearic acid every 12 hours.

At this factory the saponification of fats by means of water alone has also been successfully accomplished and rendered industrially applicable. The new autoclaves employed in this process are worked under a pressure of 15 kilogrammes per square centimetre, corresponding to a temperature of 200° C. Constant agitation of the contents is secured by means of a current of steam under high pressure, which, after having heated, agitated, and mixed the material, passes out at the top of the autoclaves by a spiral condenser, from which the condensed products escape by a regulator valve. This spiral condenser is placed in a vat containing weak glycerine liquors, which are thus condensed to 28° to 30° B. by means of the waste heat of the autoclave. This process gives in a single operation commercial glycerine and fatty acids ready to be immediately submitted to pressure.

The exhibit of the de Milly factory consisted of the following products:

Fatty acids, obtained by the saponification of tallow and of palm oil, by means of water alone, under a pressure of 15 kilogrammes per square centimetre, during a period of 7 hours.

Fatty acids, obtained by saponification of a mixture of equal parts of tallow and palm oil, by means of a 4 per cent. solution of sulphuric acid at a temperature of 120° C.

Fatty acids, obtained as above after distillation.

Oleic acid, from the saponification of tallow by water alone.

Distilled oleic acid, obtained by saponification with sulphuric acid.

Commercial glycerine, 28° B., obtained by aqueous saponification.

Distilled glycerine, colorless, 30° B.

Oleic acid soap (*savon de l'étoile*), commercial.

Toilet soap (*savon de l'étoile*), perfumed.

Stearine candles (*bougies de l'étoile*)

E. Asselin, St. Denis (Seine), exhibited interesting products recovered from waste lubricating oils from the French railways. The lubricants employed on railway carriages in France are generally manufactured by the railway companies, and consist of tallow, palm oil, olive oil, peanut oil, or colza oil, emulsified in an equal quantity of slightly alkaline water. The railway company Paris-Lyon Méditerranée, sells annually over 200,000 kilogrammes of waste fatty material which has been used on railway carriages. This is treated at the works of Mr. Asselin, and on saponification yields large quantities of free fatty acids of a light yellow color, which, after distillation, are found in all respects suitable for the manufacture of stearine candles, or of hard and soft soaps. After the separation of this product, the residues, which still contain fatty acids in combination with iron and copper, are saponified with soda, giving hard soaps called "*savons bronze*." The metallic residues are dissolved in sulphuric acid, and the solution treated with scrap iron for the precipitation of cement copper. Finally, sulphate of iron is obtained by the evaporation of the liquors. The cement copper is chiefly employed at these works for the manufacture of copper oxide, of which about 15,000 kilogrammes are made annually.

Another important waste product treated is the refuse of the mineral lubricating oils used on the railways. Fully as great a quantity of these are produced as of vegetable oils. It is impossible to extract from this mineral oil any product of value, except a very impure heavy oil, which, on account of its drying properties, is of little value. The refuse mineral oil is therefore mixed with coal dust at a temperature of 50° to 60°. On cooling the material becomes solid; it is then moulded into briquettes, and burned in the furnaces used at the factory. The material so prepared furnishes an excellent fuel, giving a very intense heat, and leaves behind an ash containing 20 to 30 per cent. of copper. By dissolving the ashes in acid and precipitating with iron, cement copper is obtained.

An important industry at these works is also the recovery of barium carbonate from the residues from sugar refineries. Of this material 900 tons were treated during the past year.

E. Calvet et Cie., Paris (works at St. Denis and Dax, Landes), exhibited refined animal oils, resin spirit, white, blue, and green resin oils.

Tessier, Huyard et Cie., Bordeaux, made a fine exhibit of products of the stearine industry, animal and vegetable oils and fats, bone-black, glue, and gelatine. This large establishment employs 5,000 tons of bones and horn and 1,000 tons of tallow annually. The prin-

cipal products of the works are 1,200 tons of bone black, 120 tons of bone oil, 60 tons of ammonium sulphate, 450 tons of stearine, 450 tons of oleine, 80 tons of glycerine, 400 tons of glue and gelatine, 1,000 tons of superphosphates, and 800,000 packages of candles.

Petit Frères exhibited an apparatus for the separation of solid stearic acid from oleic acid by cooling in thin layers. This process has lately come into extensive use, and has been favorably reported upon by a commission of the French Academy of Sciences. It has been found that the cold pressing of mixed fatty acids is best effected at a temperature not lower than 18° C., in order that the cakes of stearic acid shall contain as little oleic acid as possible. The liquid oleic acid so obtained contains about 18 per cent. of solid stearic acid, which is generally imperfectly separated by long standing in cold cellars. In many works ice-machines are employed to produce the low temperature necessary. At one works in Holland a plant capable of producing 5,000 kilogrammes of ice per hour is in regular operation. The disadvantages of this method of cooling are the great consumption of ice required and the solidity of the resulting mass of fatty acid, which proves an obstacle to complete separation by pressure. The apparatus designed by Petit Frères consists of a circular refrigerating chamber, in which the oleic acid is cooled by passing in a thin layer over a cold surface. Treatment of the resulting semi-solid mass in filter presses produces cakes of solid stearic acid and oleic acid of unusual fluidity and purity, greatly preferred to that of ordinary quality for the oiling of wool. It is claimed that this apparatus, with a consumption of 300 kilogrammes of ice per hour, produces results equal to those obtained by former methods with the use of 10,000 kilogrammes of ice. The process is now employed in several of the leading candle factories of France and Holland. The apparatus in operation was exhibited in the Machinery Hall with specimens of crude oleic acid and liquid and solid fatty acids extracted by the process.

Michaud Fils Frères, Aubervilliers (Seine), exhibited soaps and glycerine. This firm manufactures soaps from oleic acid on a large scale, and has already been referred to as the original introducer of the method of saponification of fats by means of zinc oxide.

Among other important exhibitors of soaps and stearine in the French section may be mentioned D. Leca et Cie., Poulet fils et Cie., and Chas. Roux fils, Marseilles; the Stearinerie Française, St. Denis, Exposition Collective des Stearineries Savonniers, Lyons.

UNITED STATES.

Everett Ward & Co., 6 Harrison street, New York, exhibited borax soap, white rose soap, Soncy bouquet soap, and bar soaps of various kinds.

R. W. Bell Manufacturing Company, 77 to 89 Washington street, Buffalo, exhibited laundry soap of several kinds and soap powder.

ENGLAND.

Lever Brothers, Cheshire, exhibited "Sunlight soap" of various qualities, especially prepared for use in hard or soft water. The production of soap at these works was stated to be 37,500 tons per year.

Edward Cook & Co., Bow, London, showed their gold medal primrose soaps; mottled, soft, and other household soaps; soaps for silk, woolen, paper, and other mills; all kinds of toilet soap; antiseptic and medicated soaps; export soaps suitable for all uses.

Price's Patent Candle Company (limited), Battersea, London, exhibited a variety of soaps, including that made from fatty acids obtained by decomposition of tallow by means of the magnesium salt of a fatty acid; the process is carried on in an autoclave at high pressure. Specimens of glycerine obtained in the same process were also displayed. Price's palmitin candles, made of paraffine and palmitic acid; these are of high melting point on account of the presence of the solid fatty acid, and have the transparency and high illuminating power characteristic of paraffine candles. Spiral candles produced by forcing the stearine through rifled molds, were also shown.

VIII.—INDIA RUBBER AND GUTTA-PERCHA.

India rubber, or caoutchouc, is imported into Europe and America from many tropical countries. According to statements contained in an interesting paper lately published by Hubert Price*, the following are the chief localities producing caoutchouc, and also the botanical species of the trees from which it is obtained:

Para rubber	Brazil.....	<i>Hevea braziliensis</i> .
Ceara rubber.....	Brazil.	<i>Manihot glaziovii</i> .
Carthagen rubber....	New Grenada	<i>Castilloa elastica</i> .
Nicaragua rubber.....	Central America.....	<i>Castilloa</i> sp. (?)
Mozambique rubber.....	East Africa.....	<i>Vahea guminifera</i> , etc.
Madagascar rubber	East Africa.. ..	sp. <i>madagascariensis</i> .
Assam rubber	Calcutta.....	<i>Ficus elastica</i> .
Borneo rubber.....	Borneo.....	<i>Urceola elastica</i> , etc.

The purest and best quality of india rubber is that which comes from Brazil; then follow in the order of their value the Central American, Asiatic, and African. A full and interesting description of the methods by which the Brazilian rubber is gathered and prepared for the market is given in the article quoted above.

The production of india rubber in Brazil during the last few years has been as follows:

	Pounds.		Pounds.
1883-4	23,018,600	1886-7	29,469,000
1884-5	26,147,000	1887-8	34,685,200
1885-6	28,237,000		

* Jour. Soc. Chem. Ind., 1886, p. 211.

Pure rubber softens and loses its elasticity when heated to temperatures approaching the boiling point of water; it also becomes very hard and brittle at the freezing point. For these reasons rubber found very few applications in the arts until the process of vulcanizing was discovered by Goodyear, of New Haven, United States, in 1842. This is now generally effected by kneading the rubber with finely divided sulphur, molding the mixed material into the required forms, and exposing the articles to the action of superheated steam at heavy pressure for several hours. About 2 per cent. of the sulphur enters into combination with the rubber, forming a material which is more elastic than the original substance, is unaffected by temperatures higher than that of boiling water, and does not become brittle on exposure to the cold of winter.

It was found by Parkes in 1846 that vulcanization can be effected by a few seconds' immersion of the rubber in a bath of chloride of sulphur dissolved in bisulphide of carbon. The rapid extension of this process is probably the most important change which has taken place in the india rubber industry during the past few years.

Sulphur chloride (S_2Cl_2) is a yellow oily liquid of 1.60 specific gravity. It possesses a suffocating odor, fumes in the air, and boils at $144^\circ C$. It is prepared commercially by passing washed and dried chlorine over sulphur heated to $130^\circ C$. Sulphur chloride is formed and condensed, with some volatilized sulphur, in the receiver. The chloride is subsequently freed from sulphur by distillation.

Vulcanization by sulphur chloride is chiefly applied to waterproof fabrics of wool or silk coated on one side with rubber—such as the material from which “mackintoshes” or “gossamers” are manufactured. These fabrics would be injured by the high temperature required in the ordinary process of vulcanization. Rubber vulcanized by sulphur chloride is found to contain from 0.75 to 1.25 per cent. of sulphur, and in thin sheets is as transparent as the original pure rubber.

Two methods are in use for the vulcanization of rubber by means of sulphur chloride:

(1) *The wet process.*—In this method 1 part of sulphur chloride is dissolved in about 30 parts of bisulphide of carbon, and the articles are treated by a very brief immersion in the solution. In the case of waterproof fabrics the rubber face of the goods is simply brought in contact with the surface of a roller kept wet with the sulphur chloride solution. The cloth is then warmed to drive off the excess of the solvent and complete the action of the sulphur compound. Finally, the goods are treated with a solution of ammonia or exposed to ammonia gas to neutralize the acid formed by the action of the sulphur chloride.

(2) *The vapor process.*—This method of vulcanization was patented by Abbot in 1878, and consists in exposing the goods to be

vulcanized to the action of the vapor of chloride of sulphur in a closed chamber. It is claimed by Fawsitt* that this method gives results which are inferior to those yielded by the "cold process," and that the goods are generally over-vulcanized at the surface and but little affected in the interior. The advantages claimed for the chloride of sulphur process of vulcanization are, lower cost of production, freedom of the finished material from efflorescence of sulphur, and the avoidance of injury to the goods from exposure to high temperature. It is also stated that with care in the selection of pure materials and attention to details in the process of manufacture, vulcanized rubber of much greater durability can be produced than by the common methods. Fawsitt mentions a mat vulcanized with sulphur chloride which was in constant use for 24 years. The same author lately exhibited pieces of "cut sheet," cured by himself 3 years ago, which had not suffered in the least from the action of the air.

The objections to the sulphur chloride process are the bad odor often imparted to the goods by the carbon disulphide employed, and injury to the health of the workmen caused by the fumes of that substance. These drawbacks are of course avoided in the vapor process, in which no disulphide is used. The first objection may be overcome by the use of purer material; the second by providing suitable apparatus for confining and removing the fumes of the carbon disulphide, as is generally done in well-appointed works.

Those who are interested to know more of the methods of using sulphur chloride in vulcanizing rubber, will find much valuable information in papers by Charles A. Fawsitt, F. C. S., published in the *Journal of the Society of Chemical Industry*, 1886, page 638, and 1889, page 368.

The subject of the decay of rubber on exposure to air and in contact with oily matters has also been lately accurately studied. It is well known that pure Para rubber is practically unaffected by air, and retains its elasticity unimpaired for long periods of time. Vulcanized rubber threads are not changed, even by sunlight, in an atmosphere of carbon dioxide, hydrogen, or in vacuo, showing that the oxygen of the air is the active agent in producing decay. Oily substances of all kinds affect rubber very injuriously, especially the vegetable oils, such as cotton-seed and palm oil, while mineral oils are much less harmful.

Many substitutes for rubber have been proposed, and some of them have come into extensive use for the adulteration of inferior grades of goods. Low-class waterproofing contains sometimes not more than 10 per cent. of pure rubber, the rest being made up of "substitute." The material generally used for this purpose is a compound produced by the action of sulphur chloride on certain vege-

* *Jour. Soc. Chem. Ind.*, 1889, p. 376.

table oils ; the "white substitute" largely used in England, is made from rape-seed oil. Gromot and Rivière, of Paris, have found that certain solid gums and resins may be dissolved in oleic acid (a by-product of the stearine industry) ; on evaporation of the solution they obtain an elastic substance, to which the name "Elasteine" has been given ; this resembles rubber quite closely, and is useful as a waterproofing and insulating material.

GUTTA-PERCHA.

This material was introduced into England from Singapore in 1843. The best quality comes from Borneo, and is obtained from the *Dichopsis gutta*. It differs from rubber in containing a considerable proportion of oxygen, and in its almost complete lack of elasticity. It was formerly expected that numerous important uses would be found for gutta-percha as a waterproofing material ; its property of becoming soft and plastic when slightly heated (at 50° C.), has, however, been a great obstacle to its general employment for such purposes. The present application of gutta-percha is chiefly in the manufacture of pumps, tubes, and utensils for use in chemical works, and as an insulating and waterproofing material for submarine telegraph cables. For certain purposes it is also added to India rubber in considerable proportion ; a mixture of the two substances may be successfully vulcanized, an operation which can not be performed with gutta-percha alone. Within a few years the *Balata*, a material closely resembling gutta-percha, has been largely imported into Europe from British Guiana.

FRANCE.

A. Decourdemanche et Cie., Choisy-le-Roi (Seine), exhibited pumps, valves, and tubes of gutta-percha and vulcanized rubber, cylinders covered with vulcanized rubber of various degrees of hardness, for use in sugar manufacture, calico printing, etc., all of most excellent workmanship.

Torrilhon et Cie., Paris (works at Clermont-Ferrand, Puy-de-Dôme), exhibited rubber hose ingeniously protected by a spiral of hardened rubber on the outer surface ; rubber-coated cloth for carriage-making, in various colors, vulcanized by a special process without the destruction of the colors, which always results from the ordinary method of vulcanizing at high temperature. This firm also exhibited *briquettes* of cellulose, coated with India rubber ; these are at present largely used in the construction of naval and merchant vessels. The *briquettes* have a density of only 0.140, and are made perfectly waterproof by the exterior coating of rubber. In the construction of vessels they are placed between the inner and outer shell, and serve by their buoyancy to prevent sinking of the ship in

case of collision or the penetration of a projectile. This exhibit also included belts, pipes, valves, pumps, cylinders, and various other articles of india-rubber and gutta-percha.

Société Générale des Téléphones (Usines Rattier), Paris, made a large and very fine exhibit of apparatus composed of hard and soft rubber, including large rolls covered with rubber for use in the expression of beet-juice in the sugar industry; elastic rubber thread, similar to that for which the firm of Mackintosh & Co., of Manchester has long been known; pipes, valves, couplings, belts, and articles of gutta-percha.

The India Rubber Company, of Paris, exhibited insulated wires and cables for electric bells, telephones, telegraphs, and electric light; pumps for raising acids, "cut sheets" of unvulcanized rubber used for making tobacco-pouches and surgical bandages.

Hutchinson et Cie., Paris, exhibited rubber boots and shoes, belts, valves, washers, pipes for gases and liquids, pumps for acids, billiard cushions, rubber-coated tissues and garments, life-preservers, cushions, etc.

Menier & Co., Paris, exhibited rubber hose composed of several layers of canvas united by India rubber, of remarkable strength and workmanship; blocks of hard rubber (ebonite) for use in place of lithographic stones, also many other objects in hard rubber and gutta-percha.

Similar products were exhibited by F. Casassa fils et Cie., Pantin (Seine); François, Grellou et Cie., Paris; C. Guibal, Paris; Bapst et Hamet, Paris; and others.

ENGLAND.

Bartrum Harvey & Co., Birnbaum & Sons, G. Cording, Lee Brothers, and Nicholson & Co., of London; J. Mandelberg & Co., Pendleton; the North British Rubber Company, and William Currie & Co., of Edinburg, exhibited specimens of raw and manufactured rubber, rubber cushions, pillows, bath-tubs, etc., and especially waterproof rubber-lined fabrics and garments (properly belonging to Class 36), for which the English manufacturers have long been famous.

UNITED STATES.

The Brookhaven Rubber Shoe Company, Setauket, Long Island, New York, exhibited crude rubber from various parts of the world, and specimens of the plants from which the different varieties are obtained; also many manufactured articles, shoes, boots, overshoes, etc.

The Revere Rubber Company, Boston, Massachusetts, exhibited the "Giant Patent Seamless Belt"; this is pliable on the pulleys, and can be run on either side, presenting a perfectly smooth sur-

face, while lines of strong cotton stitching, 1 inch apart, keep the belt from stretching or running crooked; the Usudurian packing, which is somewhat plastic when applied to steam-pipes to make tight joints, but goes through the process of vulcanization under the influence of the hot steam, becoming very hard. This company also showed steel armor-protected hose, and a variety of other goods for mechanical purposes.

The Waterbury Rubber Company, New York, exhibited the "Sphincter grip armored hose" invented by Mr. J. A. Coultous; this hose is protected by a spiral of galvanized spring steel, and is capable of withstanding a pressure of 1,000 pounds. The steel wire also protects the hose from abrasion, and makes it more flexible so that it may be coiled in smaller space or made to turn a shorter corner, without flattening, than if unarmored. The coil is so made that it may be cut at any point without unwinding.

Exhibits of rubber goods were also made in the Belgian and Dutch sections. In the Pavilion of Guatemala and the section of Paraguay specimens of raw rubber were displayed.

IX.—PIGMENTS, PAINTS, AND VARNISHES.

FRANCE.

A. Croulard, Paris, exhibited a variety of pigments specially prepared for the manufacture of colored papers and for fresco-painting. An important product of these works is precipitated barium sulphate, "blanc fixe," largely used in making porcelain paper and cardboard; of this Mr. Croulard makes 450 tons per year.

Lefranc et Cie., Paris, made a fine display of pure pigments, lakes, and varnishes. Among the colors shown may be mentioned zinc yellow, or precipitated zinc chromate; Indian yellow (*jaune indien*) or "*purée*," a beautiful yellow coloring matter imported from India. The origin of this pigment has, until recently, been unknown. According to Graebe,* who carefully studied its chemical constitution, it is prepared in Monghyr, a city in Bengal, from the urine of cows fed on the leaves of the Mango tree. On heating the liquid the coloring matter separates, and is pressed out, formed into balls, and dried, first over a coal fire and finally in the sun. It consists chiefly of the magnesium and potassium salts of euxanthic acid, $C_{19}H_{18}O_{11}$. Murexide yellow, the zinc salt of purpuric acid; Naples yellow, antimonate of lead; Schweinfurth's green, aceto-arsenite of copper; Scheele's green, arsenite of copper were also shown.

One of the most interesting specimens shown is the new "Pompeian blue" (*bleu de Pompeii*). This is the "coeruleum" of the Romans, a magnificent blue pigment anciently used in mural painting. Chemists have long endeavored to discover the chemical

* Annal. d. Chem. u. Pharm., 254, 265.

nature and mode of preparation of this pigment, but succeeded only in ascertaining that its color is due to the presence of copper. It is one of the most permanent colors known, and specimens of it found on the walls of Pompeii are as bright as when the color was first applied. After the fall of Rome the secret of its preparation was lost. In February, 1889, Professor Fouqué, of the College de France, announced to the Paris Academy of Sciences* that after careful analysis of large samples of the "coeruleum," he had succeeded in finding a method of preparing it in quantity. According to Mr. Fouqué, the compound is a silicate of copper and lime, and may be prepared by fusing together silica, lime, and copper oxide. By using exact proportions he obtained the substance in the form of a distinct crystalline compound. The crystals are dichroic, appearing sky-blue when viewed from the surface, and pale rose-colored from the edges. In the preparation of the color too high a heat must be avoided, or the blue tint is lost, and a green glass obtained. It is a very stable color, resisting acids, alkalies, hydrogen sulphide, air, and moisture. According to Professor Berthelot this is undoubtedly the "Alexandria blue" introduced from Egypt into Italy at the beginning of the Christian era. It is probable that this new pigment will prove very valuable, chiefly in fresco-painting.

Lefranc et Cie. displayed madder lakes made from artificial alizarine and purpurine, also lakes made from natural Alsatian madder; ivory black, actually made by carbonization of ivory and used for fine artists' colors; varnishes for fine painting, coach-painting, and the manufacture of colored papers.

E. Hardy-Milori, Montreuil-sous-Bois (Seine), made a fine display of pigments and prepared colors for fine and coarse painting and for printers' and lithographic inks, including zinc greens of very rich color, prepared by mixing zinc chromate with Prussian blue, and found especially useful in cases where the poisonous qualities of ordinary chrome yellow would be objectionable.

L. Marquet de Vasselot, Paris, exhibited cobalt blue of various shades. This is the aluminate of cobalt, made by precipitating a solution of alum and cobalt nitrate by sodium carbonate and drying and igniting the product. This firm is the only rival in France of the Royal Manufactory at Dresden, which supplies most of the cobalt pigments to commerce. The cobalt blue made by Mr. Marquet is used by the French, Belgian, and Italian Governments for the printing of bank notes. A fine series of pure cadmium yellows was also shown. These consist of cadmium sulphide—the lighter shades obtained by precipitation with hydrogen sulphide, the darker shades by means of alkaline sulphide.

Ringaud, Meyer et Cie. and Mme. Veuve Edouard Rommel exhibited specimens of French vermilion of several shades, obtained by

* Comptes Rendus, February 18, 1889.

both wet and dry processes. Mme. Rommel is the successor of the late Mr. Lange-Desmoulins, who in 1824 established the first vermilion manufactory in France.

Lorilleux et Cie., Paris, made a very fine exhibit of printing and lithographic inks of all colors and shades for typography, lithography, heliotype, steel and copper-plate engraving, and photogravure, also a variety of dry colors used in the manufacture of these inks. At the works of this firm at Nanterre the manufacture of lamp-black of special quality is carried on on a large scale by the decomposition by heat of substances rich in carbon, such as naphthalene. The gas so obtained is burned under an immense bell-shaped dome of boiler-plate, from which the soot is carried by a strong current of air to chambers of 3,000 cubic metres capacity, in which the lamp-black is deposited. The boiling of linseed-oil for the manufacture of varnishes and inks is conducted at the works at Puteaux. The oils are stored each year in immense reservoirs, in which their clarification and bleaching are accomplished by air and light only, without the use of injurious chemical reagents.

Parquin, Gauchery, Zagorowski et Lachiche, Auxerre (Yonne), exhibited large specimens of yellow and red ochers. The ocher of this locality is remarkable for its high percentage of iron, upon which the depth of color depends, and for the regularity of its composition. Analysis of the best quality of yellow ocher as it comes from the mines, shows 30.6 per cent. oxide of iron, 39.1 per cent. silica, 17.2 of alumina, and 12.4 of water. The red ocher is obtained by calcination of the yellow mineral, and shows a remarkably fine and deep color. Similar specimens of ochers were shown by Legros, Piat & Leau of the same locality.

C. Expert-Besançon et Cie., Paris, exhibited specimens relating to the manufacture of white lead. The Dutch process, in pots, is employed almost exclusively in France, and the French or Clichy process, by the action of carbon dioxide on solution of lead acetate, finds at present very little use, owing to the want of covering power of the product. At the works of Besançon seven layers of pots are employed in each chamber. Each layer contains 3,000 kilogrammes of lead. There are more than thirty chambers in the works. The pots are surrounded by spent tan-bark, which is afterward used as fuel. Four and one-half months are required for the completion of the process.

L. Faure, Lille (Nord). The founder of this establishment erected a factory at Lille in 1819, and was the first to introduce the manufacture of white lead into France. The Dutch process is still employed at these works.

According to information furnished to the writer by Mr. Faure, the total production of white lead in France is about 18,000,000 kilogrammes (or 18,000 long tons). The larger part of this is produced

at Lille. In 1888, there were imported into France 1,017,000 kilogrammes, and in 1889, 1,225,000 kilogrammes. This importation was chiefly from Belgium. The world's total production of white lead is estimated to be about 100,000,000 kilogrammes. In England, about 30,000,000 kilogrammes of lead were employed for the manufacture of white lead in 1888. France produces but little lead (8,000 tons in 1888), and is therefore dependent upon other countries for her supply of this metal. The best ores from the French lead mines were worked out ages ago by the Gauls and Romans.

Levainville et Rambaud, Paris, exhibited white lead, pigments, and varnishes; also Prussian blue made from the spent oxide of the gas works. The spent oxide is mixed with lime and exposed to the air for a long period. On leaching the mass and adding potassium carbonate potassium ferricyanide is obtained. This is crystallized and the mother liquors used for the manufacture of Prussian blue. In the manufacture of white lead the tapping of the plates or buckles to separate the pigment from the unchanged metal, and the grinding of the product, are operations fraught with danger to the workmen on account of the lead dust which is thus liberated. According to Dr. Lavrand, of Lille, the poisonous effects of lead compounds upon the system are accompanied by a decrease in the number of red corpuscles in the blood together with the exudation of iron through the urine and the perspiration of the scalp. The lead absorbed into the system appears thus to drive out the iron normally contained in the blood. At the factory of Mr. Faure great benefit has been obtained by the administration of pills of iodide of iron to the workmen threatened with lead poisoning. This remedy has in all cases greatly lessened the anemia, and has generally enabled the men to continue their work in the factory without further inconvenience. With a view to diminishing the danger of lead poisoning many improvements in the process of manufacture of white lead have been introduced within a few years. Dry separation of the white lead from the metal by hand has been almost universally abandoned. Mechanical separators are generally employed, and the material is kept wet during treatment. In addition to the benefit to the health of the workmen thus secured, the adoption of these improved appliances has resulted in an important saving of labor. At the works of Levainville and Rambaud the buckles of lead rest upon copper gratings placed above the pots. When the chambers are dismantled these gratings carrying the white lead are raised by an elevator to a mechanical separator, from which the pigment drops into pans of water, and may be removed with safety. At these works a continuous system of melting and casting the lead into buckles has been devised, which permits the accomplishment in two days of the work which formerly required a week. This firm also manufactures ferrocyanides from the spent purifying material of the gas works, and

has lately introduced calcium ferrocyanide (yellow prussiate of lime) as a commercial product at a price not above one-half that of the potassium salt.

Th. Lefebvre et Cie., Lille (Nord), exhibited buckles and white lead in various forms. At these works a process has been introduced by which the white lead in a wet state as it comes from the mills is ground directly with oil without previous drying. Most of the water is separated and expelled during the operation; the small amount which remains is finely emulsified, and aids in keeping the pigment in suspension.

Mme. Vve. Tassy de Montluc, Bar le Duc (Meuse,) exhibited white lead made by a special secret process from thin sheets of metal; it is claimed by the manufacturers that the carbonation is completed in 30 days, and that the product can not be distinguished from that made by the Dutch process. It is stated that the metal is completely transformed into white lead, and that the dangerous process of separation is thus wholly avoided. This process has attracted much attention among manufacturers for many years; the secret of the methods followed has, however, been successfully guarded.

Deschamps frères, Vieux-Jean d'Heurs (Meuse,) exhibited ultramarine of various tints. The total production of ultramarine in France is at present about 2,500,000 kilogrammes; of this amount Deschamps frères produce 1,000,000 kilogrammes, equal in value to 1,600,000 francs. The chief seat of the ultramarine industry in Europe is Nuremburg. In 1873 the transformation of blue into violet and red ultramarine was begun on a commercial scale at the Nuremburg works, and almost simultaneously in France by Deschamps frères. Very little is known in regard to the process employed in producing the violet and red colors. According to the original German patents, the violet ultramarine is produced by the action of acids, chlorine, or ammonium chloride, with air and steam, on blue ultramarine at low heat. The red variety is obtained by prolonged burning with free access of air. The violet and red ultramarine are far inferior to the blue in richness of color, but find a considerable use in the manufacture of wall-papers, and in calico printing. Deschamps frères have also a branch factory of ultramarine at Moscow, Russia.

E. Guimet, Lyons. The manufacture of ultramarine is still continued on a large scale by the family of the discoverer of this valuable product, Jean Baptiste Guimet, who founded the industry at Lyons in 1826. The production of the works is to-day not less than 1,000,000 kilogrammes per year.

G. W. Dorneman and F. Richter, of Lille, also L. Robelin, of Lyons, made fine exhibits of ultramarine of various shades.

A full and very interesting description of the modern process of

ultramarine manufacture, was lately published by Heintz, in the *Journal für praktische Chemie*, 1891, No. 1.

G. Chalmel, Paris, exhibited a variety of varnishes for different uses; varnish made with alcohol, which does not become cloudy when spread over a surface; special mat black varnish, varnishes for furniture, coach-building, and oil-painting.

L. Dida, Paris, showed transparent colored varnishes for coloring sheet metal and foil; thick enamel varnishes for decoration in relief (Byzantine or cloisonné ornamentation), varnishes for imitation of gilding, varnishes for furniture, leather, carriage-making, and photography.

Hartog et Cie., Paris, and M. R. Schmidt, St. Denis, exhibited special varnishes for railway carriages, with panels illustrating the results which may be obtained by their use.

Société Anonyme des Gommés Nouvelles et Vernis, St. Denis, made a fine exhibit of various gums and resins used in the manufacture of varnish, gum copal from Zanzibar, gum animi from Madagascar, Benguela copal, gum kauri from New Zealand, gum mastic from the island of Chios; oil varnish for buildings, furniture, carriages, and various other uses; specimens illustrating the manufacture of substitutes for India rubber.

GREAT BRITAIN.

Griffiths Brothers & Co., London, exhibited "Griffith's zinc white," a non-poisonous substitute for white lead, which has of late come into extensive use. This pigment consists of zinc oxy-sulphide, and is produced by precipitating a zinc salt from solution by sodium sulphide. The precipitate is dried and calcined in a furnace. It is claimed that the product has greater covering power than white lead. It does not act chemically upon metals, and is not discolored by gases containing hydrogen sulphide. This firm exhibited also 120 shades of glossy enamel paints, vitreous bath-tub enamel which dries without stoving and resists boiling water, metal enamels, and a variety of varnishes.

Rowney & Co., London, exhibited artists' colors, drawing pencils, brushes for oil and water-color painting, and other artists' materials.

UNITED STATES.

Henry M. Johnson, 25 and 27 John street, New York, exhibited patent dry kalsomine and fresco paints for walls and ceilings, borders, stencils, etc. These require only the addition of water to prepare them for use. Antiseptic substances are ingeniously combined with the paints, preventing all disagreeable odor.

Valentine & Co., 245 Broadway, New York, made a very complete exhibit of their well-known varnishes, with specimens of panels, etc.,

illustrating their use. Conclusive evidence of the value of these preparations was to be found in the carriage and railway departments, where coaches, street cars, and railway carriages finished with these varnishes were shown by exhibitors from most of the leading countries of the world. Valentine & Co. furnish their preparations to more than four hundred carriage manufacturers in France, Switzerland, and Germany. The total number of coaches exhibited at the Exposition was 175. Of these 108 were finished with Valentine's varnishes. It is also noteworthy that every carriage-maker who received the award of the grand prize, including Healy & Co., of New York, is a regular user of these varnishes, and had used them on the carriages shown.

F. W. Devoe & Co., New York, exhibited a series of varnishes, making a special feature of those used for coating railway passenger cars. The preparation of varnishes that will resist the heavy wear and tear to which railway carriages are subjected is a matter of great difficulty. In proof of the success which this firm has attained in this direction it may be stated that Devoe & Co. are regularly supplying nearly all the leading railway companies of the United States.

The Frederic Crane Chemical Company, Short Hills, New Jersey, showed transparent colored enamels suitable for use upon polished metals of all kinds, especially upon silver, also specimens of metals treated with these enamels.

B. F. Brown & Co., Boston, exhibited liquid and solid blackings and dressings for leather.

In the Belgian, Russian, Japanese, and other sections exhibits of pigments, varnishes, etc., were made, but presented no features worthy of special mention.

X.—PHARMACEUTICAL PRODUCTS.

FRANCE.

Société Française de Produits Pharmaceutiques, Adrian et Cie., Paris, presented a very large and varied exhibit of pharmaceutical preparations. This company was founded in 1872, with a capital of 500,000 francs. At present the annual production of the works represents a value of over 3,200,000 francs. Adrian et Cie. are widely known for the remarkable inventions they have made in apparatus for pharmaceutical manufacture on a large scale. The works are situated at Courbevoie, near Paris, and comprise eight separate buildings, devoted to the following branches of manufacture: unguents and pomades, alcoholic tinctures, extracts, sirups, powders, medicated bonbons and lozenges, pastilles and tablets, medicated capsules, granules, pills, and globules. Ten additional buildings are occupied with the manufacture of crystallized chemical products, glucosides, and alkaloids.

Among the many preparations exhibited by Adrian et Cie. the following appear most worthy of mention: various fine chemicals, chloroform, ethers, iodides, and bromides; products obtained from *digitalis*; *digitalin*, crystallized and amorphous, *digitine*, digitalic acid; amorphous *quassin*, obtained by Mr. Adrian to the amount of 15 per cent. from crystallized quassin; *eserine*, extracted from the Calabar bean; *daturine* from *stramonium*; *sparteine*, *arbutine*, and *solanine*, all finely crystallized and in large specimens. An interesting series of products derived from oil of turpentine also formed part of this exhibit, including terebenthene monohydrochloride, or artificial camphor; crystalline terebenthene dihydrochloride; terebene, $C_{10}H_{16}$, obtained from turpentine by the action of sulphuric acid; terebic acid; terpin and terpinol, the hydrates of terebenthene; a series of different terpenes and terpinols obtained from oils of lemon, lavender, thyme, and juniper berries.

Among the pharmaceutical preparations exhibited by Adrian et Cie. may be mentioned capsules of various forms, pastilles, pills, and granules made with the aid of the mechanical pill-machines displayed by the same company in Class 51. It was formerly the universal practice to prepare granules by shaking small seeds or grains of sugar in a pan, with the addition of sugar, sirup, and the medication required. This method yielded granules of nearly regular shape and size, but frequently very irregular in the proportion of the remedy contained in each. The commission appointed for the preparation of the last French *Codex* recommended, therefore, that granules should be prepared by the mechanical division of a thoroughly-mixed pill-mass in the manner usually followed in the manufacture of pills. By the aid of specially-designed apparatus Adrian et Cie. have been able to produce on a large scale pill-masses of perfectly uniform composition; and to divide them into pills and granules of exactly spherical shape and of any desired diameter. These are subsequently glazed, sugar-coated, gelatin-coated, or silvered.

Soft and dry extracts, prepared by evaporation *in vacuo*, or by the process of refrigeration, were also displayed. The process of evaporation *in vacuo* was introduced by Grandval in 1847, and has been greatly improved within the past few years. The advantage of this method over ordinary evaporation is that the temperature employed is very low (generally not above 35° to 38° C.), and the delicate and perishable constituents of the drug remain unchanged during the process. The extracts so prepared preserve the characteristic flavor and physiological action of the plant from which they are prepared, and are free from the burnt taste usually found in those prepared by evaporation on the water-bath. Solutions of these extracts are also nearly colorless. Adrian et Cie. employ a special vacuum pan, which is given an oscillating motion during the process of evaporation. This facilitates the liberation of the vapor and constantly

breaks up the crusts which would otherwise form on the surface of the liquid.

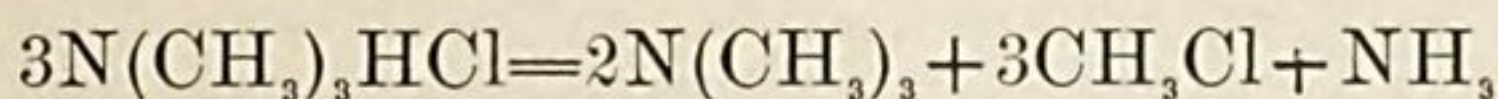
For many years attempts have been made to concentrate aqueous extracts by the aid of cold, with separation of the water in the form of ice. There can be little doubt that by this process the constituents of fresh plants may be obtained more completely in their original condition—free from the injurious effects of air and heat—than by any other method. Adrian et Cie. have overcome the mechanical difficulties which have heretofore prevented the extensive use of this means of concentration. Their method is briefly as follows: The filtered vegetable solution is poured into molds cooled by means of a powerful ammonia ice-machine of the Mignon and Rouart type. Two hundred kilogrammes of liquid can be treated in one operation. The refrigeration is continued until the liquid is transformed into blocks of ice and reduced to a temperature of 10° C. below the freezing point. The hard and dry blocks are removed and quickly ground to the fineness of loose snow. This material is then introduced into centrifugal machines and submitted to rapid rotation for 20 minutes. About 75 per cent. of the original solution remains in the centrifugal in the form of ice, while the portion that passes through contains the active principles of the plant. This is again frozen at a temperature of -20° C., and again ground and separated by the centrifugal machine. A sirupy extract, equal in amount to 12 to 15 per cent. of the solution, is thus obtained. This is then carefully dried in vacuo at a temperature not exceeding 30° C. ($=96^{\circ}$ F.). The extracts so obtained are still less colored than those resulting from evaporation in a vacuum. They give clearer solutions and retain in a greater degree the medicinal properties of the plants employed. It is probable that this method of extraction will have an important future.

A number of physiological products were also shown, *diastase* in flakes; *pancreatine*, dry peptones made from fresh beef, veal, turkey, and from white of eggs; *hæmoglobin*, by the process of Deschiens, entirely soluble in water, made from beef blood by depriving it of its fibrine.

Egrot, Paris, made in classes 50 and 51, (Machinery Hall) a most impressive exhibit of apparatus for culinary purposes and pharmacy. The Egrot steam-cooking plants have been introduced at most of the hospitals and asylums in Paris, and a very complete one on this system was employed at the restaurant on the first floor of the Eiffel Tower. A reversible steam-cooking vessel, of 1,200 litres capacity (about 300 gallons), formed part of the exhibit, also a complete column still for the rectification of alcohol, with numerous forms of stills, alembics, and autoclaves. The pharmaceutical exhibit comprised reversible steam-heated vessels for hospital use in making decoctions and poultices, and a complete vacuum-pan for con-

centration of extracts, with exhaust pump and condenser, including all the latest improvements.

A. Billault, Paris, already mentioned as the exhibitor of a remarkable series of crystallized chemical products, showed also cylinders of methyl chloride, CH_3Cl , condensed to the liquid form by heavy pressure, for use in producing local anæsthesia by the cold of its evaporation. This substance is obtained by the distillation of trimethylamine hydrochloride, a by-product of the manufacture of potash, by the process of C. Vincent, from beet-root residues. The industry is carried on on a considerable scale at the works of Tilloy-Delaune, at Courrières (Pas de Calais).^{*} After fermenting the beet-root molasses and distilling off the alcohol, the vinasse is concentrated to a sirup. Instead of calcining this residue in the open air, and allowing the products of the distillation to escape, as was formerly the practice, Professor Vincent has introduced the process of distillation in closed vessels or retorts. The distillate is a mixed product, containing ammonia, methyl alcohol, pyridine bases, fatty acids, and a considerable quantity of trimethylamine. At Courrières 90 tons per day of molasses are treated, producing alcohol and vinasses; the latter is evaporated and distilled, yielding 10 tons of crude potash, 1,500 kilogrammes of ammonium salts, and 1,800 kilogrammes of trimethylamine hydrochloride. On distillation of the latter compound in concentrated solution, decomposition takes place, with the production of ammonia, methyl chloride, and trimethylamine,



The bases are absorbed by hydrochloric acid; the methyl chloride is washed, dried, and liquified by pressure, and supplied to physicians in copper cylinders of 1 to 4 kilogrammes' capacity.

The use of methyl chloride for medical purposes has been largely developed by Dr. Bailly, of Chambly. By holding a sponge or tampon before the outlet of the cylinder, and slightly opening the stopcock, the tampon becomes charged with methyl chloride, which volatilizes but slowly, owing to the low temperature produced by its evaporation. On touching the impregnated tuft to the skin a white spot is instantly produced, with intense feeling of cold, followed by a complete loss of sensation of the part. Repeated application produces a brown coloration like that caused by a blister, followed by desquamation of the epidermis. Prolonged contact produces the well-known effects of freezing, such as inflammation, vesication, and sloughing. Methyl chloride has been found useful in minor surgical operations, and in alleviating pain in cases of neuralgia, sciatica, toothache, and headache. It has also been applied with success to the spinal column in cases of tetanus, producing immediate relaxation of the contracted muscles. The low price at which this valuable

^{*} Comptes Rendus, xciv, 6, p. 323.

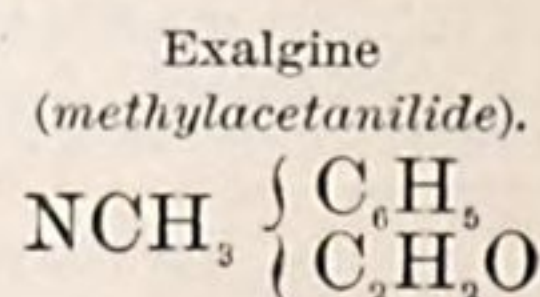
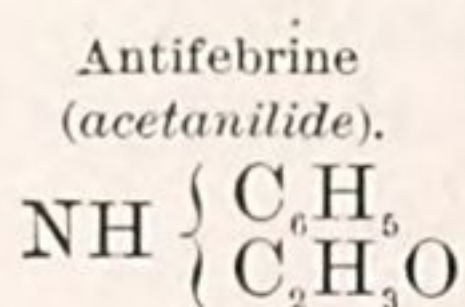
product is supplied (7 francs per kilogramme), makes it available for a great variety of purposes.

Compagnie Parisienne des Couleurs d'Aniline, Paris, displayed beautiful crystalline masses of *antipyrine*, obtained by crystallization from water, from benzine, and from ether. This substance is dimethyl-oxy-quinizine, $C_{11}H_{12}N_2O$, first prepared by Dr. Ludwig Knorr in 1886. It is made by introducing a methyl group into the product of the action of ethyl aceto-acetate on phenyl-hydrazine. As phenyl-hydrazine is made from aniline, antipyrine may be called an indirect derivative of coal-tar benzene. Antipyrine has come rapidly into use as a febrifuge, and has proved a valuable remedy for reducing the bodily temperature, and for the relief of pain in headache and neuralgia. This company are at present the only manufacturers in France. The chief supply of the material is, however, furnished by Meister Lucius & Brunig, Höchst-am-Main. During the first four months of 1888, antipyrine, to the amount of 50,000 francs, was purchased for use in the Paris hospitals. The Pharmacie Centrale at Paris is about to manufacture the same substance under the name of *analgesine*.

Brigonet & Naville, la Plaine St. Denis, made a large exhibit of organic chemical products, the manufacture of which is carried on at these works on a large scale. Aniline, artificial benzoic acid from toluene, benzyl chloride, and benzaldehyde were shown; also artificial methyl benzoate, used in perfumery under the name of "essence de Niobe;" nitrobenzene, called "oil of mirbane," or "artificial oil of bitter almonds," largely used in scenting common toilet soaps. Dimethylamine has of late acquired great importance in the manufacture of such dyes as methylene blue and dimethyl-aniline violet, and is manufactured by this firm in an unusually pure state and largely exported into Germany.

Another interesting process employed at these works is the manufacture of methylene dichloride and chloroform from methyl chloride (now a cheap commercial product) and chlorine. Methylene dichloride resembles chloroform in its effects, and has been extensively used as a substitute for the latter substance. Authorities differ as to its safety and efficiency. It is agreed, however, that methylene dichloride produces insensibility more quickly than chloroform, and that its after effects are less unpleasant.

A new remedy, "exalgine," has also lately been introduced by this firm, and now manufactured on a commercial scale. This is methyl-acetanilide, first made by Hofmann in 1874; it differs from antifebrine (acetanilide) only by the presence of a methyl group, and is prepared by the action of glacial acetic acid on methyl aniline.



Exalgine has been successfully employed as an analgesic in the Paris hospitals, and has been found to exert a marked effect in allaying pain and reducing fever.

Chassaing et Cie., Paris, exhibited pepsine, pancreatine, diastase, and peptones. This firm has long been known for the excellence of its pepsine preparations. The evaporation of solutions of these ferments is an operation of considerable difficulty, owing to the ease with which the active principles are destroyed by heat, or by the development of bacteria. Chassaing et Cie. employ for this purpose a set of forty-eight shallow pans of enameled iron, each having a capacity of about 8 litres, placed in a bath through which water at a temperature of 45° C. constantly circulates. The evaporation is promoted by the passage of a current of air, previously filtered through soft flannel and warmed to 45°, over the surface of the liquid. A constant temperature is secured by automatic regulators. The degree of heat attained is varied according to the material treated; pepsine, for example, is injured by temperatures above 45° C., while diastase may safely be evaporated at 50° or 55°. The method of dialysis is largely used at these works to increase the strength of pepsine and other ferments. By means of twenty dialysers (corrugated funnels of 2 litres capacity, each provided with a filter of parchment paper of 80 centimetres diameter) placed in four vats of enameled iron, through which a constant current of water circulates, it is found possible to treat 50 kilogrammes of pepsine dissolved in 300 litres of water. In this manner the strength of the product may be doubled in 48 hours. The great increase in the use of pepsine and the production of these works is indicated by the statement that at the time of the last Paris Exposition Chassaing et Cie. were making 400 kilogrammes of pepsine annually; in 1888 over 2,000 kilogrammes of extractive pepsine were manufactured, equivalent to 5,000 kilogrammes of the officinal preparation.

J. A. Chassevant, Paris, successor of Boudault & Callas, exhibited pepsine and other ferments, and also medicated tablets and pastilles. Mr. Boudault was the first to introduce a method for the practical manufacture of pepsine, and his process is still generally employed in all parts of the world.

C. J. Desnoix, Paris, well known for more than 30 years as the leading French maker of medicinal and surgical plasters, exhibited lead plaster (diachylon), plasters of Burgundy pitch, resin of thapsia, hemlock, etc., blistering tissue of cantharides, very convenient to use and of great permanence, court plasters, and antiseptic dressings. The works, situated at Courbevoie, are capable of producing 5,000 metres of prepared plaster per day.

L. Frère, H. Fournier et Cie., Paris (founded in 1826), exhibited

a fine series of pharmaceutical and chemical products, among which the following may be noted:

Chloral hydrate and anhydrous chloral, metachloral, chloralide, chloral-ammonia, chloralimide, chloral-urea, trichloroacetic acid, etc. Quinine salts, sulphate, hydrochloride, lactate, salicylate, valerianate. Products derived from wood; pastilles of poplar charcoal, beech-wood creosote, guaicol, terpinol, etc.

An interesting specialty of this firm is the manufacture of pills and granules, each globule of which bears upon its surface the name and dose of the medicine which it contains. This is accomplished by coating each pill with an inert envelope, which breaks up readily in water, and is easily soluble in the liquids of the stomach; this coating receives the printed impression desired. The device is certainly a source of protection to physicians and patients.

Among the chemical products exhibited were ortho, meta, and para-methyl-acetanilide, produced by the action of acetic acid on the three toluidines, and isomeric with exalgine, which melt at 107° , 64° , and 170° respectively, while exalgine melts at 101° . Acetylbenzylamide, also an isomer of the same substance, is made by the action of acetic anhydride on benzylamine.

Genevoix et Cie., Paris, made a fine display of general pharmaceutical and chemical preparations, including an interesting series of alkaloids and glucosides in large finely-crystallized specimens. *Digitalin*, a glucoside, the active principle of digitalis, was first isolated by Homolle and Quevenne in 1854; since that time digitalin has largely replaced the crude drug for medical use. The chemical and physiological properties of this glucoside have been carefully studied by Drs. Homolle and Blacquart. Fine specimens of caffeine, brucine, strychnine, cocaine, and piperine were also displayed.

P. M. Petit, Paris, exhibited a series of alkaloids similar to the above, including cocaine prepared by synthesis from benzoyl-ecgonine, which accompanies cocaine in the coca leaves; salts of sparteine from broom, and of pilocarpine, isolated from *jaborandi* in 1875 by Hardy; pamphlets containing the results of investigations by Mr. Petit on algæ and diatoms.

Société du Traitement des Quinquinas, Nogent-sur-Marne. These works were established by Mr. Armet de Lisle in 1828, and are now under the management of a son of the founder; the exhibit consisted of specimens of cinchona barks, and a very complete series of quinine salts. Thirty-two different salts of quinine were shown, twelve of cinchonidine, and nine of cinchonine. An interesting by-product is the "noir Armet," a special kind of charcoal for decolorizing purposes, prepared by carbonization of the exhausted cinchona bark; it is claimed to be superior to the best bone black in decolorizing power.

COLLECTIVE EXPOSITION OF THE FRENCH PHARMACISTS.

This exhibit was displayed in a separate set of cases, and furnished a large amount of interesting material for scientific study. Here were collected a great number of specimens illustrating the scientific work of the individual pharmacists, with books and pamphlets containing the results of their researches, and many delicate instruments designed by the exhibitors for certain exact determinations and investigations; making, as a whole, a display highly creditable to the French people and to the profession of pharmacy. Among the many specimens exhibited may be mentioned the finely crystallized rare alkaloids, picrotoxine, veratrine, atropine, absinthine, aconitine, pilocarpine, helenine, sparteine, and hyoscyamine, shown by Duquesnel; Jungfleisch's apparatus for the preparation of acetylene by incomplete combustion of gas; Berthelot's apparatus for the electric synthesis of acetylene; the apparatus used by Moissan in his recent isolation of fluorine, consisting of a platinum U-tube, with stoppers of fluorite, in which anhydrous hydrofluoric acid was decomposed by electrolysis. Specimens of crystallized *lævulose*, a form of glucose which has until recently been considered uncrystallizable, having been prepared only in a sirupy condition. Professor Jungfleisch has succeeded in obtaining it in crystalline form, by shaking the syrup repeatedly with cold alcohol, thus removing a considerable proportion of water and impurities; the purified syrup, placed in a desiccator in a cool place, forms after some time a mass of crystals, which may then be washed with alcohol and dried.

The limits of this report will not allow a description of many other interesting specimens which formed a part of this remarkable French pharmaceutical exhibit. Mention should, however, be made of the alkaloids of the pomegranate tree and of ergot, recently isolated by Tanret; preparations of *Eucalyptus globulus* and the resin of podophyllin by Delpech; preparations of the *Plantago psyllum* and *Convallaria maialis* by Langlebert; salicylic acid and salicylates by Cerckel; the gelatine capsules of Capgrand-Mothes, the successor of Mothes, who in 1833 first invented capsules of gelatine; the extracts shown by Grandval, whose father first applied vacuum evaporation to the preparation of extracts in 1847; the extracts of Duboe, Dausse & Boulanger, and of Roudel; the capsules, vesicating preparations, and dental articles of Fumouze-Albespeyres; the flexible gelatine capsules of Thevenot, especially useful in the administration of cod-liver oil, copaiba, and tar preparations; the pills, granules, and capsules of Maillard & Radanne; and finally, the pepsines, globules, and pastilles of Rigaud & Chapoteaut.

In Class 43 there were a number of exhibits which may properly be considered under the head of pharmacy.

Charles Hoffman, Paris, made a fine display of different species

and varieties of cinchona bark from Java, Madras, Bolivia, and Ceylon. The trunk of a cinchona tree (cinchona Java) was also shown.

The virtues of cinchona are indicated by the names given to the tree by the races inhabiting the localities where it is indigenous, as the "tree of life" of Peru, the "divine plant" of Bolivia, and the "bark of gold" of Java. The method of gathering the bark is a simple one. The collectors, or "cascarilleros," explore the forest, and, having found a cinchona tree, cut it down, strip it of its bark, and leave the wood to decay. This method would soon have led to complete destruction of the species if the attention of those interested had not been given seriously to the problem of culture of the cinchona to compensate for the rapid destruction which is taking place. The Dutch Government has created important plantations in Java, and private enterprises have followed this example. The cinchona has been extensively planted in India, Bolivia, Peru, Maurice, and the Himalayas. These attempts at culture have been remarkably successful, and have insured the continued supply of this valuable boon to mankind. Not only is the quantity of available bark thus increased, but its richness as well, since the cultivated cinchonas yield a higher percentage of quinine than the wild varieties, producing sometimes from 90 to 120 grains of sulphate of quinine per kilogramme.

Even the cultivated cinchona tree must, however, be sacrificed to obtain the much-prized bark. Within a few years attempts have been made to remove the latter in successive portions without destroying the life of the tree, and in such a way that the parts removed shall be constantly renewed, as is generally done in the production of cork from the cork tree. The result of these experiments has been very gratifying. A specimen of "renewed bark" from Ceylon, $1\frac{1}{2}$ metres in length, was to be seen in the exhibit of Mr. Hoffman. This was taken from a tree only 15 months after a previous cutting. The bark is of good thickness, and is of high percentage of alkaloid, containing, according to the analysis of Mr. Armet de Lisle, 60 grammes of quinine per kilogramme. The results thus far obtained are full of promise, and the renewed bark will doubtless soon be an article of commerce.

G. Coutela, Paris, made a very large exhibit of dried plants, roots, and barks, gums, and resins used in medicine, perfumery, and various industries, accompanied by a very complete explanatory pamphlet. The exhibit included a series of cinchona barks, with specimens of *C. calysaia* and *C. succirubra* grown in Paris, after careful experiments on the possibility of acclimatizing the plant. Specimens were shown of the *Fucus crispus* from the shores of the Atlantic; from this and other *fuci* the "sea-weed gelatine," or *gelose*, is prepared, and has lately found many applications in medicine, in the preparation of jellies, as a mordant in dyeing, and as a sizing material for fabrics.

ENGLAND.

Thos. Christy & Co., London, showed an interesting series of rare specimens of dried medicinal plants, roots, and fruits. Messrs. Christy & Co. have been engaged for many years in the systematic collection of plants of known or possible medicinal value, from all parts of the world, and employ a large force of agents in tropical countries, who are constantly on the lookout for new drugs, or new supplies of plants of known value. The exhibit included new and rare plants, barks, dyewoods, and a variety of standard pharmaceutical preparations. Among the novelties shown may be mentioned eucalyptus honey, produced by the black bee of Australia, which is said to have an important medicinal effect in cases of bronchitis and other pulmonary and laryngeal affections; and also *kolatina*, a semi-liquid preparation of the dried kola nut, which contains a considerable percentage of caffeine, and has lately come into use as a substitute for coffee and cocoa. The journal published by Christy & Co., "New and Rare Drugs," is well known among pharmacists.

Bishop & Sons, London, make a specialty of effervescent preparations, and exhibited granular effervescent citrate of magnesia, citrate of lithia and antipyrine, citrate and bromide of caffeine.

Burroughs, Welcome & Co., London, showed a variety of pharmaceutical preparations; lanoline, the purified fat of sheep's wool, which has a remarkable power of penetrating the skin when applied in the form of salves and ointments; lanoline soaps, pomades, and cold cream; tabloids of antipyrine, a very portable and convenient method of administration of this popular remedy. This firm also exhibited specimens of sulfonal, a new hypnotic, which has lately attracted a good deal of attention. Sulfonal, or diethyl-sulfon-dimethyl-methane, $(\text{CH}_3)_2\text{C}:(\text{SO}_2\text{C}_2\text{H}_5)_2$, was first prepared by Baumann, at Strassburg, in 1886.* It is produced by the action of acetone on ethyl-mercaptan, and oxidation of the product formed. In doses of 15 grains, or more, it produces quiet sleep, and no ill effects from its use have thus far been observed.

Another important new remedy which was shown in this exhibit is *salol*, or phenyl salicylate, $\text{C}_6\text{H}_4(\text{OH})\text{COOC}_6\text{H}_5$. It was first made by Nencki, in 1883, and its commercial production dates from 1886. Salol is a powerful antiseptic agent; it reduces fever, and is especially valuable as a remedy for rheumatism.

Phenacetin, a compound closely allied to acetanilide or antifebrine, and similar to it in physiological action, may also be mentioned as one of the many remedies which organic chemistry has supplied to the medical profession. Phenacetin is ethoxy-acetanilide, $\text{C}_6\text{H}_4(\text{OC}_2\text{H}_5).\text{NH}.\text{CH}_3\text{CO}$.

Burroughs, Welcome & Co. exhibited also a great variety of rem-

*Ber. d. D. Ch. Ges., XIX.

edies in the form of tabloids; these are extremely convenient for transportation and use, and may be noted as one of the important advances in pharmacy. Tabloids of saccharine (for diabetic patients who can use no sugar), charcoal, podophyllin, quinine, cascara sagrada, Dover's powder, and rhubarb were shown, illustrating the advantage of this mode of dispensing simple remedies, which may safely be used by patients without the direct advice of a physician. Medicine chests for travelers and explorers, as supplied to Emin Bey and Henry M. Stanley, were also displayed.

UNITED STATES.

The pharmaceutical exhibit of the United States was a very creditable one, and attracted much attention from the jury of awards. In view, however, of the many advances in pharmacy that have been made in this country during the past few years, and the influence that American preparations have exerted throughout the world, it is to be regretted that so large a number of our leading manufacturers failed to send exhibits. It is believed that a fully representative display of American pharmaceutical products would have excelled the exhibit of any other country, not excepting France.

Fairchild Brothers & Foster, 82 and 84 Fulton street, New York, made a fine exhibit of digestive preparations, for use as remedies in indigestion and dyspepsia, for the artificial peptonization of foods for the use of invalids, for the conversion of cow's milk into a form closely resembling human milk, and for the removal of diphtheritic, and other false membranes. Peptic preparations: pepsin in scales, in powder, and in tablets; essence of pepsin, an active extract from calves' rennet. Pancreatic preparations: trypsin, the fibrin-digesting principle of the pancreatic juice, especially prepared for use as a solvent for diphtheritic membrane. Extractum pancreatis, a light yellow powder, containing all the digestive ferments of the pancreas.

Peptonizing tubes, an accurate and convenient method of supplying the peptonizing powder for the preparation of peptonized milk for the sick; peptogenic milk powder, which converts cow's milk into a wholesome substitute for human milk; diastatic essence of pancreas, for the digestion of farinaceous foods; tablets of pancreatic extract in convenient form for administration.

Ten years ago the pepsins most largely in use were preparations of indefinite composition, consisting chiefly of inert material, such as milk-sugar or starch. At that time the pancreatic ferments had been but little studied, and their use, for other purposes than emulsifying fats, had not been developed. By introducing the active principles of the gastric juice and pancreas in the form of concentrated preparations of definite composition, and by the development of the uses and capabilities of the pancreatic ferments, Messrs.

Fairchild & Co. have made great advances in this important field, and have conferred a benefit upon the public. Fairchild's pepsin is claimed to possess greater digestive power than any other in the market. Of egg albumen, suspended in water in the proportion of 150 grains to the ounce, acidulated with 1 per cent. by volume of hydrochloric acid, and maintained at a temperature of 105° F., one part of this pepsine will dissolve 3,000 parts in 5 or 6 hours.

W. R. Warner & Co., Philadelphia, made a large and striking exhibit of sugar-coated pills, tablets, capsules, and effervescent granulated salts. The pills exhibited were of excellent workmanship, and were especially noticeable on account of their ready solubility, requiring only 4 or 5 minutes for complete solution in water. The exhibit included many specialties of this firm, among which should be noticed "ingluvin," a preparation of pure fowl pepsin, which has lately come into extensive use all over the world as a remedy for nausea and indigestion.

The Chesebrough Manufacturing Company, State street, New York, made a full display of their well-known vaseline and vaseline preparations. This substance was first prepared by Mr. R. A. Chesebrough, of New York, in 1871, from the residuum of petroleum distillation. It is obtained by the purification of this residuum by repeated filtration through bone black. Vaseline forms an opalescent jelly, consisting of hydrocarbons, chiefly of the paraffine series. It melts at about 95° F., and does not oxidize or become rancid on prolonged exposure to the air. For this reason it has come into very extensive use for the preparation of salves, pomades, and cerates. It is also extensively used in France for the process of "enfleurage" or absorption of the delicate odor of flowers in the preparation of perfumes. Vaseline is used as a waterproof dressing for leather, for the prevention of rust upon metals, as a lubricating agent, and for numerous other purposes. Among the standard preparations of vaseline exhibited were mercurial ointment, zinc ointment, citrine ointment, Goulard's cerate (of sugar of lead), and simple cerate, which with many others are kept in stock by the company. The United States Pharmacopœia recognizes thirty-six distinct officinal preparations of which vaseline forms the base. White, yellow, and red vaseline were shown, also perfumed, carbolated, camphorated, and arnicated vaseline, vaseline camphor ice, cold cream, and soaps.

Seabury & Johnson, 21 Platt street, New York, exhibited India-rubber pharmaceutical and surgical plasters, antiseptic dressings and absorbents. The use of India-rubber as an ingredient in the coating of plasters was first introduced by this firm and attracted attention at the Paris Exposition of 1878. The effect of the rubber is to preserve the incorporated medicaments, insuring unimpaired activity through long periods of time, and at the same time to add to the adhesiveness and pliability of the plasters. Medicated cottons, gauzes,

ligatures, bandages, lambs' wool, lint, jute, and oakum were also exhibited, together with a large assortment of medical and surgical appliances catalogued under Class 31. Mention should be made of the "sulphur candle," an ingenious device for convenient disinfection, already mentioned under the head of sulphur (page 542), and *hydronaphthol*, a nearly odorless non-poisonous germicide.

NORWAY.

The Norwegian Commission to the Exposition displayed a large collection of specimens of medicinal cod-liver oil extracted from the fresh livers by steam and purified by freezing. (This method is in general use in the United States on the New England coast, where a large amount of oil of fine quality is produced.) The fresh livers are washed and placed in a vat, in which the oil is separated by the heat of steam at low pressure. The oil is drawn off and allowed to freeze by exposure to the cold of winter. The solid mass is pressed through canvas bags. The pure oil runs through, leaving solid stearine and refuse tissues behind. Oil so prepared is very light in color and has very little unpleasant flavor.

Many other exhibitors displayed cod-liver oil of various qualities for medicinal use and for currying leather.

FRENCH COLONIES.

Algiers.—Tar and tar preparations, native medicinal plants and roots, castor beans, seeds of *Datura stramonium* or thornapple, leaves of the *Verbascum thapsus* or mullein, resin of the root of *Thapsia silphium*, which has lately come into extensive use in France as a counter-irritant; essence of geranium and myrtle, orange flower water. A series of products extracted from the date-palm were shown, and included an astringent resin from the woody fiber of the tree, very useful in the preparation of plasters, and stated to have remarkable healing properties. The pollen of the date-palm is used by the natives of Africa as a cure for cracks in the skin. The stamens of the flower yield a decoction which is beneficial in cases of bronchitis.

Gabon-Congo.—Kola nuts and preparations made from them. The natives of Guinea chew kola nuts, and value them highly for their stimulant effect and power of producing wakefulness. This is explained by the presence of *caffeine*, which the nuts contain to the amount of more than 2 per cent. Unlike coffee, kola nuts contain no tannin.

New Caledonia.—Turmeric, root and powder; extracts of niaouli and citronella; resin of auracaria; specimens of ginger root.

Réunion.—Cinchona bark and preparations.

St. Pierre and Miquelon.—Oil of wintergreen, cod-liver oil.

Senegal.—Specimens and preparations of the *Cassia occidentalis* and other native medicinal plants.

SOUTH AMERICA.

Argentine Republic.—Cocoanut oil and other vegetable oils.

Bolivia.—Coca leaves and elixir of coca. The exportation of coca from South America has immensely increased since the wonderful properties of cocaine became known. In 1888, 730,000 pounds of coca leaves, and about 200,000 pounds of extract, or "crude cocaine," were exported from Peru.

San Domingo.—Castor oil, sassafras, extract of rosemary.

St. Salvador.—Pistachio oil.

Venezuela.—Balsam of copaiba, cocoa butter, castor oil, resin of the locust tree, extract of sarsaparilla.

SWITZERLAND.

J. H. Pestalozzi, Waedensweil, Zurich, exhibited beautiful specimens of crystallized milk-sugar, in slabs and columns; acetic acid and lactates.

JAPAN.

A number of large blocks of Japan wax, from the *Rhus succedena* and other species; crystallized menthol, oil of mint, fruits of the wax tree and lacquer tree (*Rhus vernicifera*).

Exhibits of pharmaceutical products were also made in the sections of Belgium, Holland, Russia, Greece, Spain, and Portugal.

XI.—PRODUCTS OF PETROLEUM DISTILLATION.

Since the Exposition of 1878 a new aspect has been given to the petroleum industry of the world by the remarkable development of the Russian oil fields. The region about Baku, on the shore of the Caspian Sea, has yielded small amounts of oil for more than two thousand years, but it is only within the past decade that the great extent and productiveness of the deposits have become known. At the present time the total production of petroleum in the Baku region is greater than in the Pennsylvania oil fields. The Russian petroleum deposits have lately been fully described by Redwood* and Mendelejeff,† both of whom visited the locality, and carefully studied the occurrence of the oil and the future prospects of the industry. From their reports it appears that the yield of the Baku wells has increased from 6,400 metric tons in 1873 to 2,541,000 tons in 1888. During the first seven months of 1889 the total production of petroleum in the United States is estimated at 1,801,800 tons, while that of Baku was 2,049,180 tons. In the United States there are at pres-

*Jour. Soc. Chem. Ind., 1885, p. 71.

†Ibid., 1889, p. 753.

ent over 11,000 working wells, producing on the average not more than 5 barrels per day each, while at Baku there are only about 200 productive wells, averaging about 280 barrels each per day. The price of crude oil at the wells is not over 25 cents per barrel, as compared with 95 cents per barrel in the United States.

The crude oil is chiefly refined on the spot, and the products are distributed either by tank steamers on the Caspian, or by rail to Batoum, on the Black Sea, 560 miles distant. The railway crosses the Caucasus Mountains at a height of over 3,000 feet. A pipe-line over the mountains has been strongly urged, but its construction has not yet been commenced. There are fifty or sixty refineries in operation at Baku; the process followed is that of continuous distillation, the oil passing through a long series of stills. About one-half the refined oil produced comes from the works of Nobel Brothers, to whose energy the development of the Russian oil industry is chiefly due.

The character of the crude petroleum of Baku is totally different from that of Pennsylvania. Its specific gravity is 0.870 to 0.875, while that of American crude oil is 0.800 to 0.820. On distillation, the Russian product yields only about 27 per cent. of illuminating oil, flashing at 32° C. (90° F.), while the American yields more than 70 per cent. of such oil. The residue, after distilling off the light-oil, may be made to yield 15 per cent. of "solar oil," flashing at 220° F., resembling the American "mineral sperm," and about 30 per cent. of lubricating oil. The latter is remarkable for its high viscosity, which makes it especially useful for heavy slow-running machinery. At 60° F., the viscosity of Russian lubricating oil of 0.915 specific gravity is fully six times that of American oil of the same density. The Russian petroleum differs also from that of Pennsylvania in containing practically no paraffine. Although this substance would in itself be a source of profit, its absence greatly simplifies the manufacture of good lubricating oil, which will not solidify in cold weather. Only about 10 per cent. of the total quantity of residue obtained is, however, treated for the manufacture of lubricating oil; the remainder of the heavy oil is chiefly used for fuel. By means of the Lenz oil-burner, in which the oil is carried in a spray by a jet of high-pressure steam against a "bonnet" of fire brick, it is possible to burn the oil completely and economically. More than one hundred steamers on the Caspian Sea and Volga River, the railway to Batoum, and the refineries at Baku, use oil exclusively as fuel. The production of compounds of the aromatic series by the destructive distillation of the heavy oil has lately been worked on an experimental scale. The operation is carried on in a regenerative furnace at a red heat. The first distillation gives about 30 per cent. of tar, containing 15 to 17 per cent. of 50 per cent. benzene; a second distillation of the heavier portions of the tar gives a further quan-

tity of benzene, with a considerable amount of naphthalene and anthracene.

The illuminating oil, or kerosene, obtained at Baku is purified by treatment with sulphuric acid and caustic soda. At Nobel's works the acid is manufactured from Daghestan sulphur. The composition and properties of the Russian kerosene have lately been carefully studied by Engler,* who also gives full accounts, with illustrations, of the processes of extraction and distillation employed at Baku. The Russian kerosene is more homogeneous than the American; the latter shows, however, a somewhat higher illuminating power. Fractional distillation of many samples of each gave the following results:

	Below 150° C.	150° - 290° C.	Above 290° C.
Russian. . .	8.0	86.6	5.4
American. . . .	16.9	57.1	26.0

The portions distilling between 150° and 190° showed also very different flashing-points, namely, Russian 113° F., American 84° F. It is evident that the samples of American kerosene examined were of the character of the "export oil" usually sent to European markets, to which our refiners purposely add as large a quantity as possible of naphtha and heavy oils, and the flashing-point of which is far below the legal standard which prevails in most parts of this country. Russian kerosene has only to a small extent replaced the American in the chief importing cities of Europe, as may be learned from the recent reports of Consuls Chambers, Mason, and Bis-singer.†

Many rumors of the probable speedy exhaustion of the Caucasian oil fields have lately been circulated. These are emphatically denied by Professor Mendelejeff,‡ who was sent by the Russian Government to investigate the question of the permanence of the deposits. According to the above well-known authority the region will yield an abundance of oil for a very long period. The surface deposits in the immediate neighborhood of Baku have greatly diminished in yield, the supply from the great flowing wells has fallen off, and it is now necessary to bore to a greater depth than formerly. At lower levels, however, abundant supplies of oil are obtained. It is stated, also, that the Baku oil basin is only one of many localities in the Caucasian region which will yield great quantities of petroleum. The small increase in production of the deposits as a whole is to be attrib-

*Dingler's Pol. Jour., 260, pp. 337, 433, 481, 525; 261, p. 29; and 262, p. 47.

†U. S. Consular Reports, No. 92, April, 1888.

‡Jour. Soc. Chem. Ind., October 31, 1889, p. 753.

uted to difficulties of transportation and lack of market for the product, and not to approaching exhaustion of the oil-bearing strata. Productive oil-fields have also lately been developed in Galicia, and it is expected that the whole of the Austrian Empire will soon be supplied with burning and lubricating oils from this source.

FRANCE.

Boulfroy et Cie., Clichy (Seine), exhibited products of the distillation of Russian petroleum, illuminating and lubricating oils and vaseline. The factory and refineries at Baku belonging to this firm produce annually 8,000,000 kilogrammes of refined oils.

A. Richard frères, Tiflis, Batoum, and Marseilles, exhibited petroleum products from the factories at Tschiknaveroff at Baku.

Similar products of the Russian oil industry were shown by L. Roguier, Paris.

Desmarais frères, A. Deutsch et ses fils, Pluche et Cie., and the Société Anonyme des Huiles Minérales des Colombes, all of Paris, exhibited Pennsylvania petroleum and a variety of products obtained therefrom—naphtha, kerosene, lubricating oils, pitch, and vaseline. Safety oils flashing above 100° F. were also shown. The use of kerosene for lamps in Paris is still very limited, and a great prejudice exists against petroleum products on account of their supposed dangerous character. In view of the poor quality of most of the burning oils sent to Europe from this country, it can scarcely be said that this prejudice is ill-founded. Safety oil ("huile de sûreté"), which can not be ignited by a flame in an open vessel, and flashes above 100° F., is still an article of luxury in Paris, and retails at about 1 franc per litre, or more than five times the price of the same oil in New York.

UNITED STATES.

Borne, Scrymser & Co., New York (A. Coleman, agent, Paris), exhibited a fine series of mineral lubricating oils of various grades and densities, suitable for cylinders, locomotives, and all kinds of machinery.

F. S. Pease & Co., Buffalo, New York, exhibited lubricating and illuminating oils. These oils were used in the machinery department of the Exposition, as they were also in the machinery sections of previous Exhibitions—Paris 1867, Vienna 1873, Philadelphia 1876, and Paris 1878. The annual production of these oils represents a value of \$300,000. This company has received sixteen awards at previous Exhibitions.

XII.—PRODUCTS OF FOREST GROWTH AND FOREST INDUSTRY.

The French section included several beautiful displays of blocks and polished slabs of native and tropical ornamental woods. Among these the exhibit of Girardot was one of the most striking; a large polished slab of speckled mahogany, specimens of watered mahogany, a great polished block of ebony from Africa, specimens of various beautiful woods, thuya, olive, rosewood, amaranthe, Hungarian ash, amourette (with beautiful tiger-like stripes) from French Guiana. The most imposing specimen shown was the trunk of a magnificent mahogany tree (*Acajou cedra*), $2\frac{1}{4}$ metres in diameter, polished on one side.

Nazarian frères, Paris, exhibited a colossal hazel burl (*Corylua columna*), 6 feet in diameter, from Turkey in Asia, veneers of different woods, and a single sheet of veneer cut from bird's-eye maple, mounted on rollers in such a way as to allow inspection of its entire length.

C. Viguez fils, Paris, also made a fine display of polished woods, spotted mahogany from China, San Domingo mahogany, and Madagascar ebony. Equally fine exhibits of ornamental woods were made by Profit & Neveu, and L. Mougenot, Paris.

Delique frères exhibited many specimens of woods injected with various colors; artificial ebony, made by injecting a black dye, closely resembling true ebony.

Large exhibits of cork barks from France, Portugal, and Algiers, with specimens of cut corks of various forms, all of fine quality, were made by A. Barigny, O. Baletton et Cie., J. Drouillet et fils, Vve. J. P. Brun et fils, and the Société des Liéges d'Edoug (Algiers), all of Paris. The latter company showed also an interesting series of sections of cork trees of different ages, showing the growth of the bark, and large photographs representing the method of gathering cork bark and preparing it for market.

The French section included numerous exhibits of charcoal, tan-bark, and tanning extracts, timber for purposes of construction, and a variety of articles of wood and straw.

Algiers.—A great number of exhibits of cork, specimens of native woods, *Eucalyptus globulus*, and *Eucalyptus rostrata* (red gum), thuya, etc.

Collections of ornamental and medicinal woods formed part of the exhibits of the French colonies, Brazil, the South American republics, Japan, India, and other countries.

New Zealand.—Large and beautifully polished specimens of ornamental woods, *Dammara australis*, (kauri) *Dacrydium cupressinum* (rimu), *Podocarpus totara*, *Facus menziesii* (tawhari), *Librocedrus bidevilli* (kawaka).

Victoria, Australia.—Beautiful polished woods; *Acacia melanox-*

lon (blackwood), *Eucalyptus rostrata* (red gum), *Eucalyptus amygdalina*.

Specimens of cork bark and finished corks were shown in great abundance in the sections of Spain and Portugal.

UNITED STATES.

The complete and interesting exhibit of forestry products presented by the United States is described in the report of Professor Riley on the Agricultural Section (Group VIII).

XIII.—AGRICULTURAL PRODUCTS NOT USED AS FOOD.

OILS, FATS, AND WAXES.

Blanc fils aîné, Bourgogne et Cie., Marseilles. This firm is one of the most important among the great manufacturers of vegetable oils in the south of France. The works produce 4,500,000 kilogrammes of castor oil and 5,200,000 kilogrammes of cocoanut oil. The castor oil is used in dyeing and calico printing and the manufacture of lubricating oils and certain special kinds of soap. The cocoanut oil is chiefly employed in soap-making. The castor-oil cake remaining as a residue after expressing the oil contains 5 per cent. of nitrogen and is valuable for use as a fertilizer. The cocoanut-oil cake serves chiefly as a fodder for cattle.

Maurel et Prom, Bordeaux, made a fine exhibit of peanut and sesame oils of remarkable clearness and purity. The peanuts employed are obtained from Cayor, in French Senegambia. 25,000,000 kilogrammes of peanuts and sesame seed are treated yearly, with the production of 8,000,000 kilogrammes of oil and 10,000,000 kilogrammes of oil cake. Until very recently peanut oil has been used only for burning in lamps and for soap-making. The cold pressed oil made at these works has, however, found extensive use as an article of food, and is largely employed as a substitute for olive oil. It is also successfully used in the manufacture of oleomargarine, and is said to give the latter an agreeable nutty flavor. The peanut-oil cake obtained is almost white in color, contains $7\frac{1}{2}$ per cent. of nitrogen, and is found to be an admirable fattening fodder for cattle. A map of Senegambia was also displayed, showing the peanut districts and the location of the company's warehouses.

P. Marchand frères, Dunkerque (Nord), exhibited a fine series of seeds, oils, and oil-cakes. The materials chiefly used are peanuts from Senegal, sesame, and hemp seed. This immense establishment employs five hundred workmen, and treats annually 45,000,000 kilogrammes of seed, producing 15,000,000 kilogrammes of oil and 30,000,000 kilogrammes of oil-cake. The sesame oil-cake has proved

an especially good fodder, as might be expected by the following analysis by the director of the Station Agronomique du Nord:

	Sesame-oil cake.	Linseed cake.
Moisture.....	12.54	11.53
Albuminoids.....	33.93	31.37
Oil.....	9.60	9.94
Carbohydrates.....	3.17	5.37
Extractive matter.....	12.09	22.91
Cellulose.....	10.57	9.43
Phosphate of lime.....	5.06	4.73
Carbonate and sulphate of lime.	4.62	1.84
Potash and soda salts ...	0.36	0.57
Silica and oxide of iron.....	3.06	2.31
	100.00	100.00
Nitrogen.....	6.230	5.022
Phosphoric acid ...	2.420	2.172
Potash.....	.121	.213

Réné Callette, Moeres (Nord), exhibited yellow corn, rice, oil, and oil-cake. This manufacturer is an important distiller and produces 20,000 hectolitres (528,000 gallons) of alcohol per year. As by-products oils and oil-cake are obtained.

A. Deutsch et ses fils, Paris, made a fine display of vegetable oils of many kinds, linseed from Azoo, Bigarre, and Bombay; castor, poppy, native, and Danube colza, sesame from Africa, etc. Large photographs were shown representing the operation of oil-pressing as conducted at the works. Mr. Deutsch exhibited also, in Class 45, a complete series of products of the distillation of Russian and American petroleum.

Many exhibitors in the French section displayed collections of dried medicinal plants, specimens of hops, prepared fodders, etc.

XIV.—CHEMICAL METHODS OF BLEACHING AND DYEING.

Chlorine continues to be the reagent universally employed for bleaching vegetable fibers. No other oxidizing agent appears to equal bleaching powder in efficiency or convenience, and none can compare with it in cheapness. Hydrogen peroxide, though useful for wool and silk, is extremely slow in its effect on vegetable tissues. It is stated that if the action upon cotton of bleaching powder and hydrogen peroxide of equal oxidizing power be compared, the former shows in 5 minutes a result greater than that produced by the latter in 48 hours. This great difference, and also the fact that fabrics bleached with chlorine contain that element in an insoluble form, have led Hurter to conclude that it is available chlorine, and not available oxygen, that is required for bleaching. Calculated on the

basis of oxidizing power, bleaching powder is also about seventy-four times cheaper than hydrogen peroxide.

Bleaching powder must, however, be used with care, in order to avoid injury to the strength of the fiber. Lunge finds that when hydrochloric, sulphuric, or oxalic acids are used with bleaching powder, free chlorine is liberated, and acts injuriously upon the fiber, producing also more or less corrosion of the metal work of the apparatus, and injury to the health of the workmen. Carbon dioxide, on the other hand, liberates the chlorine in the form of hypochlorous acid; there are, however, many inconveniences in its use on account of its gaseous form. Lunge proposes to employ weak acetic acid; a very small quantity is sufficient, as it acts over and over again. This produces free hypochlorous acid, which does not injure the fibers, and effects a great saving in bleaching powder.

The value of carbon dioxide in producing active bleaching effects was pointed out by Dr. Witz, of Rouen. Upon this is founded the Thompson bleaching process, patented in England and other countries in 1883. The practical details of this method have been worked out by Mather in England, and the process has been rapidly introduced in various countries during the past few years, and appears likely to revolutionize the bleaching industry. The goods are introduced into a revolving kier, so arranged that it may be hermetically closed. A very weak solution of bleaching powder is run in and drained off closely, and carbon dioxide is introduced under pressure through the hollow spindle. The operation is repeated several times until the bleaching is complete. It is found that this process produces much less injury to the fiber than ordinary methods, and causes a great saving of time, material, and manipulation. The cost is not more than 30s. per ton of material treated.*

Electric bleaching.—The proposal to use electricity for the production of chlorine or bleaching liquors has often been made; most experimenters have, however, found electricity a very uneconomical means of effecting the decomposition of chlorides, and have regarded the process as impracticable on a commercial scale. For example, Jurisch† finds that the production of the equivalent of 1 kilogramme of bleaching powder by the electrolysis of calcium chloride requires an expenditure of power equal to the consumption of 18 kilogrammes of coal, whereas, by the Deacon-Hurter process, only 0.5 kilogramme is required.

The Hermite electrolytic bleaching process, patented in France, England, and other countries in 1885, has lately attracted a good deal of attention. The process is based upon the decomposition of a solution of magnesium chloride by a current of electricity, with the production of bleaching liquor. The apparatus consists of a trough of

* English patent No. 2051, February 12, 1886.

† Chemische Industrie, 1888, No. 5.

galvanized iron containing the solution. The positive electrodes, consisting of a series of ebonite frames carrying sheets of platinum wire gauze, are immersed in the solution, alternating with the negative electrodes, formed of circular plates of zinc. The latter are kept in constant revolution by a shaft; an ebonite knife bearing against each plate removes any deposit which may form upon it.

The process was described at length by Messrs. Cross and Bevan in a paper read before the Society of Chemical Industry, in London, March 7, 1887. According to the statements contained in that paper, the Hermite process requires 570 horse-power for the production of 100 kilogrammes of chlorine per hour; this is equivalent to the production of 600 pounds of bleaching powder. The writers claim, however, that the bleaching effect of the liquor is twice as great as the amount of available chlorine in it would indicate, and state that the efficiency of the whole process is equal to the production, by means of a 50 horse-power engine, of 1 ton of bleach per day of 24 hours. Hurter,* however, points out that the results obtained by Cross and Bevan are higher than theoretically possible by Faraday's law of electrolysis, and by a very complete series of careful experiments proves that nothing like the figures quoted can be obtained in practice.

On the other hand, the Hermite Company, in the circular presented to the jury of the Exposition, guarantees results which, though not so remarkable as those quoted by Cross and Bevan, are still high enough to make the industry very profitable. Using a current of 1,000 ampères, the company guarantees the production of an amount of bleaching liquor in each cell, equal in efficiency to 100 kilogrammes of bleaching powder every 24 hours, with a force of 9 horse-power (of 75 kilogranime-metres.) It is stated that the process is found especially advantageous in the bleaching of paper-pulp. It has been adopted on a large scale by the following important paper-makers:

Darblay, père et fils, Essonne, France.

Darblay, père et fils, Worgl., Tyrol.

Montgolfier et Cie., La Haye-Descartes, France.

S. D. Warren & Co., Boston, United States.

W. A. Russel & Co., Boston, United States.

Evans & Owen, Cardiff, England.

Frieberger Papierfabrik, Weissenborn-Sachsen, Germany.

Papierfabrik Steyrermühle, Aichberg, Austria.

The first four of the above-named firms have lately extended their plants after a prolonged trial of the process.

If the figures stated by the company in their guaranty are even approximately correct, there can be little doubt of the economy of the process. Assuming that for every 9 horse-power the equivalent

*Jour. Soc. Chem. Ind., 1887, p. 337.

of 100 kilogrammes of bleaching powder per day of 24 hours is produced, then 90 horse-power will produce the equivalent of 1 ton per day. Allowing 15 cents per horse-power per day as the cost of power in a large plant, we have \$13.50 per day, or not over one-third the cost of a ton of bleaching powder in this country.

The question of the application of electric methods to chemical industry is one of great importance, in view of the powerful currents at low cost which have been placed at the disposal of manufacturers by the development of electrical engineering during the past ten years. Very little has been done up to the present time in the direction of working out the most advantageous conditions for electrochemical transformations, and there is every reason to expect that careful experiments will result in overcoming many of the difficulties thus far encountered, and will point out the way to the economical application of this form of energy. As an indication of the present aspect of the question, the results lately obtained in the electrolysis of common salt may be cited. Hempel,* who made a series of careful quantitative experiments on this reaction, finds that 1 horse-power, calculated as 680 volt-ampères, may be made to yield 64.5 grammes of chlorine and 260 grammes soda-crystals per hour. From this, calculating the alkali as soda-ash, we have

1 horse-power = 1,548 grammes (=3.41 pounds) of chlorine, and 2,308.8 grammes (=5.09 pounds) soda-ash, per day of 24 hours; or,
586 horse-power will produce 1 ton chlorine and $1\frac{1}{2}$ tons soda-ash per day.

The cost of this power can hardly exceed 12 cents per horse-power per day, including attendance, etc.; or, for 600 horse-power, say, \$72 per day. Making a liberal allowance for interest on cost of dynamos and building, \$100 per day would fairly represent the running expenses, as far as the cost of decomposition alone is concerned. As 1 ton of chlorine is equivalent to 3 tons of bleaching powder, these figures, at the present prices for this product and for soda-ash, would appear to leave a considerable margin of profit. It is very probable that the use of water power would reduce the cost of the operation very materially, and that practical working on a large scale would lead to important economies and increased production. It is of course impossible to give an estimate of the total cost of the finished products, since the process has not been tested on a manufacturing scale. Hempel's experiments, however, are sufficient to show that there is nothing visionary in the expectation that electrical methods may in the near future play an important part in the great chemical industries.

The electrolysis of potassium chloride is far more promising than that of salt, on account of the greater value of the products obtained. Over 80,000 tons of potassium chloride are mined at Stass-

* Ber. d. Deutch. Ch. Ges., 1889, p. 2475.

furt each year, and a large part of this is converted into carbonate, chiefly by the Leblanc process. As potash sells for nearly five times the price of soda ash, it is evident that the electrolytic process for the manufacture of potash and chlorine from the chloride might easily be made successful. This industry is already in successful operation at Griessheim, near Frankfort, where steam power of 1,000 horse-power is used. If the accounts thus far received in regard to the success of the process shall be confirmed, there is reason to believe that electrolysis may be the method of the future for the manufacture of potash.

By modifying the apparatus in such a manner that the products of electrolysis may react upon each other, potassium chlorate may readily be obtained from the chloride. As already stated under the head of general chemical products, this industry has lately been established at Vallorbe, Switzerland, using a water-power of 1,000 horse-power and is already seriously threatening the future of the Weldon-Pechiney chlorine process.

DYEING.

The recent remarkable development of the production of coloring-matters derived from coal-tar has brought about great changes in the dyeing industry. These colors present a great variety of tints which were unattainable with the use of natural dyestuffs, and produce these shades directly upon wool and silk without the use of mordants. A great drawback in the use of these colors has been their tendency to fade on exposure to light, a property common to nearly all the coal-tar dyes. It has been found, however, that this fault may be largely corrected by the use of suitable mordants. At the present time, the artificial colors are rarely used alone, and are usually fixed upon the fabric by means of some substance capable of forming an insoluble compound with the coloring matter. The mordants most successfully employed are fatty acids or tannin. The latter, on account of its cheapness, is generally used, and is found applicable to wool, silk, or cotton. The tannin is usually rendered insoluble by means of a bath of tartrate of antimony. For certain colors, such as eosine, an insoluble fatty-acid salt is used as a mordant; as, for example, the salt of magnesia or zinc produced by impregnating the fabric with magnesium or zinc sulphate, and passing it through a bath of soap solution. Sulphur, precipitated upon the fabric by the action of sulphuric acid on sodium thiosulphate (hyposulphite), is also an effective mordant, and is largely used in dyeing wool with aniline green.

In dyeing wool black by means of logwood, the use of iron as a mordant has been generally abandoned, and chrome blacks, obtained by boiling the wool with potassium bichromate before dyeing, are

chiefly employed. This method has the advantage of loading the fiber less and leaving it more elastic.

Many vegetable dyestuffs formerly much used have been generally replaced by artificial dyes. Redwood, safflower, orchil, lacdye, and madder are now but little used. The manufacture of dye-wood extracts has greatly increased, and these now form an important article of commerce. Fine exhibits of extracts were made at the Exposition by E. Coez, St. Denis; Ch. Meissonier, St. Denis; A. Dubosc, Havre; Guinon, Picard & Joy, St. Fons (Lyons); A. Koulek, Puteaux, and others. These exhibits included prepared extracts of logwood, quercitron, madder, fustic, Brazil wood, etc. Flavin or quercitron extract is largely imported into Europe from America, and has proved very valuable for dyeing yellow or orange on wool, generally with tin mordants.

Madder has been almost entirely superseded by alizarine, which is now made in enormous quantities from coal-tar anthracene. The old "emulsion process" for dyeing Turkey red on cotton, requiring sometimes as much as three months for its completion, and consisting of fourteen distinct operations of oiling, steeping, dyeing, and clearing, has given place to the "sulphated oil process," which may be completed in 24 hours. The oils employed are known as "sulpho-oleate" or "sulpho-ricinoleate," and are produced by the action of sulphuric acid on olive and castor oils, respectively. When these are used with an alumina mordant, a basic alumina salt of the fatty acid remains in the fiber and serves to fix the coloring matter with great tenacity.

There are several natural dyestuffs for which no satisfactory substitutes have yet been found, and which are still in undiminished use. Among these may be named catechu, fustic, logwood, sumach, turmeric, and indigo. The latter is at present generally reduced to indigo-white for use by zinc dust or by the acid sodium hyposulphite, NaHSO_3 , obtained by treating sodium bisulphite with zinc. The artificial production of indigo by synthesis was accomplished by Professor Baeyer, of Munich, in 1878, by a series of reactions of a complicated character, as a result of years of patient investigation. In 1881 Baeyer succeeded in producing indigo by a much simpler method, and hopes were entertained that the artificial product would soon be manufactured on a large scale. The starting point of the process is cinnamic acid, $\text{C}_6\text{H}_5.\text{CH}=\text{CH}.\text{COOH}$, which is itself manufactured from benzal chloride (a derivative of coal-tar benzene) by the action of sodium acetate. By treatment of cinnamic acid with nitric acid ortho-nitro-cinnamic acid is obtained, and is converted into ortho-nitro-phenyl-propionic acid, $\text{C}_6\text{H}_4(\text{NO}_2).\text{C}\equiv\text{C}.\text{COOH}$, by the addition of bromine and treatment with caustic potash. Finally, by the reduction of this latter product by an alkaline solution of glucose, indigotine or indigo blue, $\text{C}_{16}\text{H}_{10}\text{N}_2\text{O}_2$, is obtained. The manufacture of

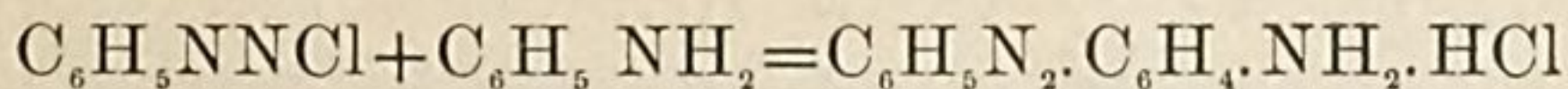
the nitro-phenyl-propionic acid is now carried on to some extent by the Badische Anilin-Fabrik, and it has been used to produce indigo blue on calico by printing with a mixture of the acid, glucose and alkali, and steaming the printed fabric. The process has, however, not been generally adopted, and it must be said that the artificial production of indigo has exerted no influence upon the dyeing industry. This is doubtless owing to the abundance and cheapness of the natural product, with which the synthetic process, though simple and inexpensive, can not compete.

Eosine, one of the most beautiful of the coal-tar colors, introduced in 1874, promised at first to replace cochineal, but has been found to be very perishable, and has practically gone out of use for all purposes except the production of certain delicate dichroic reddish-green shades.

The most important advance in the coal-tar industry which has taken place since the last Paris Exposition is the introduction of the *azo-colors*, discovered by Peter Griess, the manufacture of which, on a commercial scale, was begun in 1878. Since that date the use of the new class of dyes has very rapidly increased, and many new shades have been produced of remarkable beauty and stability.

The azo-colors are derivatives of azobenzene, $(C_6H_5)_2N_2$, and azonaphthalene, $(C_{10}H_7)_2N_2$. They may be divided into two general classes:

(1) Diazo-colors, produced by the action of amines or phenols on diazo-compounds; as, for example, the action of aniline on diazobenzene chloride, producing amido-azobenzene hydrochloride, the so-called aniline yellow, a dye not at present much used except in the preparation of other colors,



The sulphonic acid derived from the above is known as "acid yellow," and is largely used. This class includes also the tropæolins, as *tropæolin orange*, or phenyl-amido-azo-benzene; *chrysoidine* or diamido-azobenzene, $C_6H_5N_2.C_6H_3(NH_2)_2$, formerly much used, but now replaced by newer colors; and the valuable phenylene brown, the base of which is triamido-azobenzene, $C_6H_4(NH_2)N_2C_6H_3(NH_2)_2$. Allied to these colors is *rocelline*, or fast red, B-naphthol-azonaphthalene-sodium sulphonate, $C_{10}H_6(NaSO_3)N_2C_{10}H_6OH$, a color which has come very largely into use, and with other azo reds has very largely replaced cochineal.

(2) Dis-azo colors: These are more complicated in constitution than the preceding class, and contain the group (N_2) twice. Among the colors of this class are the well-known *Biebrich scarlet*, and *Crocein scarlet*.

The "tetrazo" colors are of similar character, and are derived from benzidine, $(C_6H_4)_2(NH_2)_2$. They may be regarded as formed

by the union of two diazo-molecules; examples of this class of colors are to be found in *chrysamin* and *Congo red*, which are among the most valuable of modern artificial dyes.

The azo-reds have largely replaced cochineal, the importation of which into Europe has been reduced one-half within a few years; these colors can not, however, take the place of cochineal for dyeing wool scarlet for military purposes, as they have far less power of resisting the fading effect of sunlight. Picric acid has also been almost wholly replaced by the azo-yellows.

The present aspect of the dyeing industry has lately been reviewed in an interesting manner by Dr. Reimann,* from whose paper the above notes are in part taken.

The following notes on the exhibits of coal-tar dyes at the Exposition were kindly furnished the writer by Dr. W. R. Orndorff, of Cornell University :

COAL-TAR COLORS.

Though the manufacture of artificial dyestuffs has become a very large and important industry, the number of exhibitors at the Exposition was not great, and the number of products having any claim to novelty was very small. In 1884 the value of the coal-tar colors annually produced was stated to be \$23,000,000, divided as follows:

Germany	\$15,000,000
Switzerland.....	3,000,000
France and England.....	5,000,000

As no German manufacturer was represented at the Exposition, and as Switzerland sent only a single exhibit, it is easy to understand why the coal-tar industry was so poorly displayed at the Paris Exposition of 1889.

Since 1878 there has been important progress in the color industry, but the advance has been by no means so marked as during the previous decade. It has consisted rather in the suggestion of new processes than the discovery of new dyes. The result has been generally the cheapening of the products, and the production of a better article. Some new dyestuffs have been made, but they are comparatively unimportant. The discovery of a method of synthesis of indigo, though an event of great scientific importance, has led to but little in the hands of practical dyers, probably owing to the cheapness of the natural product.

The reader who desires a complete résumé of the development of the coal-tar industry and its related branches is referred to the valuable work of P. Friedlander, entitled "*Fortschritte der Theerfarbenfabrikation*" (Berlin, 1888). Nothing more will be attempted here than to give a brief notice of the firms exhibiting and of some of the products shown.

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Brigonet & Naville, La Plaine St. Denis, exhibited many of the products obtained from coal tar and used in the manufacture of colors. These were for the most part finely crystallized, and appeared to be products of great purity. A few dyestuffs were also exhibited, made from trimethylamine. The new remedy *exalgine* (methyl-phenyl-acetamide or methylated antifebrin) may be mentioned among the specialties of this firm that attracted attention.

Compagnie Parisienne de Couleurs d'Aniline au Tremblay-Creuil exhibited many dyestuffs of great beauty and importance, among which may be noted:

Ponceaux R, RR, 3R. Amaranth de Creuil.
Bordeaux. Ponceaux de Paris R, 2R, 3R, 4R.
Orange 2. Alizarine yellow.
Fast red. Azarine.
Methylene blue. Methylene green.
Acid green. Parafuchsine.
Acid fuchsine. Blue carmine.
Rhodamine.

This is the only firm in France by whom the antipyrine of Knorr is made. Crystals of this substance of great beauty were displayed. Lanoline extracted from suint was also shown.

Durand, Huguenin et Cie., St. Fons, Lyons, distill and manufacture the products used in the preparation of dyestuffs. They make

Galleine. Gallocyanine.
Ceruleine. Indophenol.
Naphthalene rose. Muscarine.
Fuchsine (free from arsenic).

The indophenol and gallocyanine are new dyestuffs, and deserve a word. Indophenol is obtained by reducing the hydrochloric acid salt of nitroso-dimethyl-aniline with zinc, and then treating the reduction product with the sodium compound of naphthol and potassium bichromate. This indophenol yields tolerably fast blues of shades that resemble those of indigo. It yields a *leuco* body on reduction, which on oxidation gives the indophenol again, exactly as in the case of indigo. This property is made use of in dyeing with the substance. Gallocyanine or *violet solide* results from the treatment of the hydrochlorate of nitroso-dimethyl-aniline with gallic acid. It gives shades resembling alizarine violets, and may be used with many other colors. Another specialty of this house is fuchsine, free from arsenic, made from nitrobenzene. Of this pure and beautiful product these works produce 40,000 to 50,000 kilogrammes per year.

Gilliard-Monnet et Cartier, Lyons, exhibited aniline colors and those derived from resorcin and its derivatives. Azo-dyes are also manufactured by this firm. The violets, greens, and blues are particularly deserving of mention. Many fine chemical preparations

were also exhibited, such as phenol, synthetical thio-chlorofluorescene, dichlorophthalic acid, hexachloride of carbon, and other preparations which possess scientific interest or are useful in the preparation of various dyestuffs. Another specialty is the manufacture of dyewood extracts. The following are some of the colors made by this firm:

Chrysoline, cyclamine, cyanosine, various violets from rosaniline, diamond green, benzidine red and yellow (azo-dyes), benzidine blue, tropäolines, and indoline (produced by the action of nitroso-dimethylaniline upon B-naphthol. This color gives a blue on mordanted cotton). *Blue monnet* (leucothionene), *blanc monnet*, etc.

Guinon, Picard et Joy, St. Fons, Lyons, exhibited specimens of *orseille* and its derivatives, indigo and its derivatives, picric acid, aniline colors, and various vegetable extracts. The specialty of the house is the manufacture of tannins. Among the dyestuffs exhibited were the following:

Induline. Orange, II, III, IV.

Chryseine. Coralline, yellow and red.

Flavine. Hematine.

Azuline. Indigo-carmin.

J. Ruch et fils, Pontin, exhibited for the first time at an exposition. They showed a number of recent and valuable dyestuffs. The brilliant purpurine, diamond red, and diamond blue made by this firm are new members of the series of azo-dyes, which have the property of dyeing cotton goods without the use of costly mordants (tannin, etc.) This house makes a specialty of this class of dyes, manufacturing Congo reds, Congo brilliant, Corinth brown, and Congo brown, all of which dye cotton directly. These are all azo-dyes, and are made from tetrazo-diphenyl or tetrazo-ditolyl by the action of various reagents. Another class of compounds made by this house are the "brilliant scarlets." These are azo-dyes, belonging to the class usually called *ponceaux*, and used for dyeing wool, silk, cotton, and jute. Ruch et fils also manufacture malachite green, orceine S, azofuchsine, blue direct, quinoline yellow, red violet, orange. Both the crystallized substances from which the dyestuffs are made, as well as the dyes themselves, were of fine quality and great beauty.

Société Anonyme des Matières Colorantes et Produits Chimiques de St. Denis, A. Poirrier et G. Delsace, presented one of the best exhibits of dyestuffs at the Exposition. Specimens of aniline and other coal-tar derivatives were shown; also aniline colors, extract of *orseille* and cudbear, and artificial alizarine. Among the specialties may be mentioned the colors used for dyeing cotton. These are derivatives of the oxyamines which were discovered by Noeltzing and Rosenstiehl. They give very beautiful fast colors on cotton. The St. Denis reds, made by this house from the azoxyamines, are also very valuable and interesting dyes. Nitroso-dimethylaniline yields

a new dye, called by this firm *nigrosine*. It gives gray on cotton properly mordanted, and may be used in toning down the tints obtained with methylene blue. Among other products may be enumerated, fuchsine, malachite green, citronine, brilliant green, green B., orange I, II, III, IV, eosin, rocelline, violet de Paris, chrysoine, yellow 2, ponceaux, induline, phenylene brown, safranines, etc. Antifebrine, or acetanilide, was also exhibited among the products of this house.

Outside of France there were only two exhibitors of coal-tar colors. One of these was from England, the other from Switzerland.

The Clayton Aniline Company of Manchester, England, exhibited aniline and many other products derived from coal tar. Among these may be mentioned nitro-products, toluidines, and xylidines, benzidine, and many azo-compounds. Among the dyes were the following: carnotine red, carnotine orange, carnotine maroon and browns. These are probably azo-colors. This company also exhibited mordants used in dyeing, such as sulpho-oleates and sulforicinoleates of potassium, sodium, and ammonium.

Société pour l'Industrie Chimique, Bâle. This company is the successor of the old house of Bindschiedler & Busch. They exhibited many fine crystallized specimens both of intermediate products and dyes. Among the intermediate products made are diethyl and dimethyl-aniline, diphenylamine, nitroso-diphenylamine, tetramethyldiamido-benzophenone, benzidine, tolidine, amido-azo-compounds, fluoresceine and tetra-chlorfluoresceine.

Among the dyes shown were the following:

Red dyes.—Rosaniline, erythrosine, eosines, cyanosine, safrosine, safranine, rose bengale, rhodamine.

Orange, yellow, and brown dyes.—Orange MM, naphthol yellow, citronine, tartrazine, auramine, chrysoidine.

Green dyes.—Green solide, Helvetian green.

Blue dyes.—Rosaniline blue, alkali blue, blues for silks and cottons, indigotine, Victoria blue, induline.

Violet dyes.—Violet B, acid violet, alkali violet.

This firm makes a specialty of manufacturing the antipyrine of Dr. Knorr, and exhibited specimens of this valuable remedy together with all the products used in its manufacture.

The following sketch of the exhibits in Class 46 was contributed by Mr. Decaux, director of the dye works of the Gobelin Tapestry Factories, Paris:

THE DYEING INDUSTRY.

From the remotest times brilliant colors have been attractive to the eyes of mankind, therefore at an early period efforts were made to reproduce the beautiful tints presented by natural objects, such

as flowers, insects, and birds, the rich colors of which are chiefly developed in tropical countries where the warmth and light of the sun bring out their full brilliancy.

The arts of painting and dyeing date, therefore, from the remotest antiquity, and in their origin the processes followed in their application were of the simplest kind. Colored earths and the juices of plants were employed in the earliest attempts to practice these two arts, destined later to serve, in the case of painting, for the highest manifestations of human thought, and in the case of the dyeing industry for the embellishment of human apparel, and finally for the coloring of tissues employed for various uses.

In ancient times certain colors were the attribute of royal power, and it is with the description of these colors that the history of the art of dyeing begins. The processes for the application of colors remained for centuries in the hands of practical dyers, handed down only by tradition, and often masked by an accumulation of superfluous drugs or manipulations designed solely to prevent the recognition of the essential features of the operation.

During the first century of our era certain authors gave descriptions of processes which could only have been invented after the dawn of chemical science; that is to say, about the end of the former century.

The researches of Berthollet on the bleaching action of chlorine were an important advance toward the philosophy of the art of dyeing, but it was not until the early part of the present century that commerce with India created in France the industry of calico printing, based upon the scientific processes now employed. The factories of Rouen and those of Jouy, near Paris, began to imitate the oriental fabrics which had excited the admiration of all Europe. The industry of wool-dyeing, which had long remained stationary, acquired two centuries ago a color which is still one of its most valuable acquisitions. Cochineal scarlet, called Gobelin scarlet, fixed by means of tartar and tin-salt, made at this period such a sensation by its beauty and permanence that a legend stated it to have been communicated by the devil to Gilles Gobelin, for a period of ten years, in exchange for his soul. This amusing anecdote proves the importance of this color, which on account of its richness and durability has resisted even in our own day the invasion of the colors derived from aniline. Commerce across the great oceans facilitated the introduction into Europe of tinctorial woods, plants, and insects suitable for dyeing purposes, such as logwood, Brazil wood, indigo from India, safflower, and cochineal.

The centenarian savant (Chevreul) who has lately passed away from the directorship of the Gobelin dye-works endeavored to separate from tinctorial plants and woods the pure coloring matters which

they contained. Hematine, bresilene, luteoline, etc., were the results of these experiments.

The three primary colors, red, blue, and yellow, from which all other colors are derived, are obtained by numerous more or less complicated processes. On cotton, blue tints are obtained by indigo, logwood and a salt of copper, or Prussian blue; red shades are developed by cochineal, madder, Brazil wood, or safflower, while yellows may be produced by any of a great variety of plants of which only certain ones have retained their place in practice, such as fustic, turmeric, barberry, Persian berries, etc. Cotton is also colored by chemical products, as, for example, chrome yellow, which appears to have been the first definite chemical compound used in dyeing. This was followed by iron-rust, manganese, and finally by Prussian blue, which was employed to produce colored designs upon cloth. Under the direction of Oberkampf the process of calico-printing received an important impulse. The use of madder, with the aid of alumina or iron mordants employed either separately or mixed, and of different degrees of concentration, yielded the most varied shades of rose, red, violet, and even black, which were employed in the production of designs in the process of calico printing. The most important of these tints, was, however, Turkey red, which consists of the coloring matter of madder fixed upon cotton. This color formerly required a considerable number of operations in order to produce a red of full purity. These processes were long retained without important modification, until the scientific study of the coloring matter led to the simplification of its production. Since Graebe's discovery of artificial alizarine, the most important contribution to the art of dyeing among its many modern acquisitions, the method of production of Turkey red has been greatly simplified and shortened, making it possible to carry on the process at much lower cost in spite of the increased beauty of the shades obtained.

The history of this improved color is one of the most interesting in the whole field of the dyeing industry, and indicates the present tendencies in its transformation. The earlier natural coloring matters are being replaced by products identical in their chemical composition and in their applications.

Another color, faïence blue, obtained by printing with the constituents of the indigo-vat, the color of which is developed and fixed by subsequent operations, increased still further the variety of effects obtainable in calico printing. The qualities of these colors, and their resistance to the air and to bleaching agents to which cotton fabrics are subjected, have led to their retention in practice. It should be added that within a few years certain new fibrous materials, such as jute, ramie, etc., have been added to flax and hemp, but are only substitutes for cotton, and do not present the same aptitude as the latter substance for the fixation of coloring matters. The

low price of cotton and its valuable qualities will, moreover, always remain an obstacle to the industrial development of these new textile materials.

The dyeing of wool and silk, which are animal substances, presents quite different conditions from that of cotton, and in general the coloring matters which fix themselves upon animal fibers can not be fixed upon cotton, at least without the use of quite different processes. Indigo carmine, which readily dyes wool and silk, can in no way be fixed upon cotton, linen, hemp, or ramie. Safflower red, on the other hand, is easily fixed upon cotton and silk, but does not dye wool.

The conditions and processes of dyeing vary, therefore, according to the nature of the material to be treated. Printing upon wool has replaced printing upon cotton in temperate and cold countries. Fashion has also added its influence to that of natural causes. Finally, the peculiar qualities of woolen goods, which "hang" better, in addition to the abundance of woollens imported into Europe, have also favored this transformation both for wearing apparel and furniture.

The use of albumen or blood in printing soon replaced that of mordants combined with the coloring matter. The fixation of the albumen, mixed with soluble or even insoluble colors, upon the fabric by means of steam was an important advance in this industry. In dyeing wool with solid colors the old processes continued to be employed without important modifications except in the mechanical appliances required. Hand labor was replaced by machines, which gave more uniform and perfect results, while the methods of cropping and steam-priming lent to the fabrics a beauty which they had not hitherto possessed. From motives of economy, or for the purpose of producing a variety of effects, tissues were woven of different fibers, and under this new form entered extensively into trade. Fabrics of wool with cotton warp, and those of silk and wool which preceded them, introduced complications into the process of dyeing on account of the different capacity of fixing colors which these fibers possessed. It was necessary to make two successive dyeings, varying the mordants and temperatures of the bath in order to obtain a uniform color upon the fabric. It will thus be seen that very slight modifications have been introduced in the nature of the dyeing materials employed.

The necessity of progress, or rather of *change*, which asserts itself constantly without regard to the question whether the changes demanded are real improvements, led to a search for new materials or tints which should be more beautiful, more brilliant, or more easy to fix economically.

Blue colors had up to that time been produced only by indigo, logwood, and copper salt. Indigo carmine, which had replaced the earlier infusion, was more fresh in color, but unhappily offered little

resistance to the fading action of light. These were the only blues employed. Napoleon I, in consequence of the continental blockade, had offered a valuable prize for the discovery of a coloring matter which should replace indigo, at that time difficult to import. Many experiments were made, resulting in a method of fixing Prussian blue upon silk. This color was given the name of "Napoleon blue" or "Marie Louise blue," according to the intensity of the shade; but the chief object in view, the fixation of this blue upon wool for the uniforms of the French army, was not attained until some years later. At St. Denis, in 1833, Messrs. Louchon, Malartie, and Poncet solved this problem by allowing sulphuric acid to act on ferrocyanide of potassium in a dye bath while the temperature was gradually raised. The white potassium ferrous ferrocyanide which is produced fixes itself little by little upon the wool, oxidizes in the air, and takes a fine blue color, superior to that produced in the indigo vat. By the addition of tin salt to the bath the color is given a more violet tone. This dye, so permanent in the air, was well worthy of retention; but unfortunately the time and skill required to produce it have caused it to be replaced by other blues, easier to fix, but inferior in quality and intensity.

Yellow colors were always produced upon silk and wool by means of weld, the most durable of all colors of this kind; later fustic and turmeric were employed, and picric acid was proved to be a dye of great beauty, which could be easily fixed without a mordant. The popularity which this color attained led weld to be abandoned. It was, however, not long before it was found that the advantages presented by picric acid in dyeing wool and silk were only apparent, since it is so unstable that one hour of exposure of the dyed fabric to the sun destroys the purity of the color, while in a few days it takes an aventurine brown tint.

Some years more had passed when the attention of chemists was attracted to the use of purpurate of mercury, discovered by Proust; but at that time the material was rare, and the uric acid by which it was produced was obtained only from serpents' excrement. Under these circumstances the employment of the new color was quite impracticable. The guano of the Chincha Islands, already largely used in agriculture, furnished a large supply of uric acid; this substance, transformed into murexide and combined with a salt of mercury, may be fixed upon wool, yielding a magnificent cherry-red color. The zinc salt gives a fine orange yellow. Unfortunately the instability of this color led to its rejection; it was found that the cherry-red changed spontaneously into yellow on the folds of the fabric. The poisonous character of the salts of mercury was another obstacle to the industrial use of this color. Nevertheless, in attracting the attention of chemists to the study of coloring matters, this substance did a great service to the dyeing industry.

Aniline, an oily liquid, shown by Laurent to give a violet coloration under the influence of oxidizing agents, was originally obtained by distilling indigo (*anil*) in presence of an alkali. There was at first no reason to hope that colors could be obtained from aniline more economically than from murexide; but the labors of Berzelius and Dumas had accustomed chemists to transformation by substitution. Benzene, which occurs in abundance in the coal tar of the gas works, became the starting point of a new industry of artificial coloring matters, which, by producing a great variety of dazzling colors hitherto unknown, has revolutionized the dyeing industry. Unfortunately the instability of many of these tints has produced very disappointing results, on account of their injudicious adoption under conditions which should have prohibited their use, as in the dyeing of fabrics for apparel, furniture, flags, and carpets.

The transformation of benzene into aniline furnished an inexhaustible supply of this material. From aniline pure violets and reds were obtained by the action of chloride of tin, arsenious acid, chromic acid, etc. Fuchsine, obtained by Verguin, was made the starting point for the preparation of many very different colors, including blues and greens. The substitution of analogous groups in these coloring matters modified the original shades. Many of these dyes fix themselves on the fabric without the aid of a mordant, it being only necessary, in order to obtain the most brilliant and beautiful shades, to steep the material for longer or shorter time and at varying temperatures in the solution of the dye.

Aniline, which gives a violet on treatment with an oxidizing agent such as calcium hypochlorite, was the point of departure for all the colors of this class. Aniline violet was first obtained industrially by Perkin, in 1856, and appeared in commerce under various names. In 1858 Verguin produced a beautiful cherry-red dye, which took the name of *fuchsine*. Hofmann studied this coloring matter, and proved it to be the salt of a base which he called *rosaniline*. It dyes wool and silk a fine bright red color without the use of a mordant. Since that time a great number of chemists have subjected aniline to the action of all agents which promised to yield colors, oxidizing, reducing, or introducing organic groups. In this way were obtained blues, greens, violets, yellows, browns, and blacks, in fact all the colors which make up the solar spectrum. All these colors are of remarkable brilliancy, and their use is so simple that they have been universally adopted in practice. Unfortunately a very large proportion of these colors are extremely fugitive. Chemists have therefore made efforts to reproduce artificially the earlier natural colors, which, though often of inferior beauty, resist comparatively well the action of air and light. In 1868 Graebe and Liebermann accomplished the synthesis of alizarine, the coloring principle of madder, from anthracene, one of the constituents of coal tar. This has proved

to be one of the most remarkable and fruitful discoveries in the field of modern chemistry. Still later, many chemists occupied themselves with the problem of the artificial production of indigotine. Although the synthesis of this valuable coloring matter has been accomplished, the cost of the artificial product is still so high that it can not replace the natural dye-stuff.

Such, then, are the transformations which the dyeing industry has undergone during the past thirty-five years. The results attained lead to the hope that science will furnish the art with more simple and perfect processes, and will eventually find means to secure the permanence of color which is lacking in most new shades.

We will now review briefly the various products of the industry sent from all parts of the world to the Exposition of 1889.

In the preparation of yarns and fabrics for dyeing but few changes are to be noticed. Cotton, linen, hemp, and ramie have always been more or less completely bleached by the old processes, using alternately alkaline baths and chlorine in weak solution, gradually raising the temperature to boiling. For stuffs which are to remain white certain manufacturers continue the operation by prolonged exposure of the goods to light and moisture in the open air. Blueing with ultramarine gives a slightly bluish white which is sought for in the trade.

Wools are scoured, passed through weak alkaline carbonate solutions at a temperature of 65° to 70° C., and sometimes through baths of soap.

Silks are for the most part not steeped so long in soap solution before dyeing as formerly. Since this fiber is sold to the weavers by the pound, it is sought to preserve the gum which covers the raw silk to the amount of 22 to 25 per cent. of its weight. By preserving the gum the silk is rendered more supple, and it is afterward dyed. This process has been practiced for half a century. Silks are often "charged" to increase the weight, especially those dyed black or brown, usually with tannin and iron salts. In this manner it has been found possible to quadruple the weight of the silk, a process which enables the manufacturer to sell the fabric at very low price, but by which the natural brilliance of the fiber is lost.

The silks of Tussah, which are naturally brown, have been bleached by means of hydrogen peroxide, a process which allows the fibers to be dyed in fresh and bright colors.

A French inventor, Mr. L'Hermite, exhibited an electrolytic machine for the production of chlorine for bleaching purposes.

A new fibrous material, invented by Count de Chardonnet, received a high award. It presents a remarkably brilliant luster, resembling spun glass, and is produced from gun-cotton dissolved in ether and alcohol and drawn through water from a capillary glass tube. By means of a ventilator the evaporation of the solvents is

promoted, and the fibers are dried without adhering together. This silk may be colored in solution before drawing; it is used only in combination with silk, cotton, or other fibers. This ingenious process imitates the production of silk by the silk-worm, but the very combustible character of the product may give rise to accidents. In the forestry exhibit of the minister of agriculture a similar process was to be seen in operation. Many machines for dyeing were shown by English, Alsatian, and French exhibitors. Most of these dye the wool on great drums, which cause the material to pass through the dye-baths. The wool is then drawn and spun to the required number. Others use mechanical apparatus to pass the skeins through the dye-vats. Finally, many forms of apparatus for washing the skeins were shown in the French and English sections. All the mechanical appliances for dyeing fabrics were united in Class 58.

The United States was represented by only one exhibit. Garner & Co., New York, showed a variety of prints upon cotton, evidently made with a view to extensive sale at moderate price. They resemble the former products of the Rouen factories, and show chiefly good alizarine colors. There is every reason to expect that these fabrics will find ready sale.

France exhibited a variety of products: cotton dyed with alizarine indigo and ceruleine green, of which the neighborhood of Rouen possesses the monopoly; dyed skein-silk in beautiful but unstable artificial colors, and wool died with the same substances. The cotton fabrics are either dyed in the vat or printed with artificial colors, these colors are afterward developed upon the material. With the exception of the alizarine Turkey red, all the colors used are very perishable. Silks are at present dyed in the piece for the sake of cheapness; this is, however, a serious drawback, since in spite of their beautiful finish they are far from possessing the beauty of the silks dyed in the skein which have for a century given fame to the cities of Lyons and St. Etienne. The woollen fabrics, or those of mixed wool and cotton, or wool and silk, are dyed with the same artificial colors; they are of fine appearance and very well finished, but show little durability in actual service. Finally, the prints upon cotton, from Rouen, show remarkable progress in respect of good taste in design, the result of borrowing artists and printers from Alsace.

After France, Russia has made the greatest progress, especially in the employment of alizarine colors, specimens showing the use of which make up nearly the whole of this very extensive exhibit.

Belgium sent chiefly bleached linen thread and goods dyed in the indigo-vat; also woollen yarns for cloths and draperies.

Switzerland showed cottons printed in Turkey red with warps of different colors. Specimens of the same character were displayed in the Swedish sections.

England showed very few fabrics which deserve mention from the point of view of the dyeing industry.

Portugal showed printed furniture coverings on more or less heavy material, of a style and design appreciated in that country.

France and Russia, therefore, are the countries which exhibited the greatest number of striking specimens of dyed goods. In conclusion we may repeat the observation that in dyeing wool and silk, beautiful but very perishable colors are now universally employed. Efforts are being made to dye these materials with alizarine, and thus to obtain fast colors, but the resulting shades are lacking in richness, and can not compete with those generally used. Cotton alone has largely profited by the introduction of artificial alizarine, the discovery of which has greatly simplified and improved the production of reds and violets on this material.

It is then to be expected that followers of chemistry, after having revolutionized the dyeing of fabrics and fixed upon them the most dazzling tints, will undertake and carry through further researches, the object of which will be the production of colors which shall be as durable as the fabrics to which they are applied.

XV.—LEATHER AND SKINS.

The various kinds of leather may be divided into the following groups: (1) Sole leather. (2) Curried leather. (3) Enameled or patent leather. (4) Morocco. (5) Tawed leather. (6) Chamois leather and parchment.

SOLE LEATHER.

Dry and salted hides are very largely imported into Europe, especially from North and South America and Australia. Oak bark is still the tanning agent most extensively used for the best qualities of leather, though owing to its cost and small percentage of tannin, it is not unusual to mix with it a large proportion of cheaper and more vigorous tanning agents. Other tanning materials largely used are *divi-divi*, a bean pod from South America; myrabolams, from India; Australian mimosa bark; valonia, the acorn-cup of an evergreen oak growing in the East and imported from Smyrna; the hemlock extract made in North America from the bark of the hemlock pine. Many other materials rich in tannin are also used, such as quebracho wood and extract, from South America. In the United States tanning with hemlock bark is very extensively carried on; as this material is very abundant and cheap, a large amount of tanned leather is exported to Europe from this country. The hemlock gives the leather a decided reddish tint, by which it may readily be distinguished from that treated with oak bark.*

* An account of the tanning materials employed in Europe has lately been given by Mr. W. J. Salomon, in the *Shoe and Leather Reporter*, May, 1891.

Fine specimens of sole leather, chiefly tanned with oak bark, were shown by many exhibitors in the French section. Leather belting of very fine appearance was also displayed by several exhibitors, among whom may be especially mentioned, Corbeau, Gruel & Ferret, of Pont Audemer (Eure), and A. Domange, Paris. Specimens of leather tanned with *garouille*, from the south of France, were shown by two or three firms; owing to the unpleasant odor which this tanning agent imparts to the leather it is now much less employed than formerly.

Exhibits of sole leather were also to be found in the sections of Belgium, England, Russia, Switzerland, and several other countries.

In the English section the Eglinton Chemical Company made a full exhibit of products of the "Chromate tanning process" which that firm has developed and widely introduced during the past few years. It has long been known that several inorganic salts, such as sulphate of iron, bichromate of potash, and alum, will form insoluble compounds with gelatine, and many attempts have been made to use these substances in the tanning of heavy leather. A successful method of using bichromate of potash was at last worked out by Dr. Heinzerling, in Germany, and has been gradually perfected by the Eglinton Company since 1880. The process as now worked has been found applicable to all kinds of hides, from walrus to calf-skin. The finished leather is chiefly used for boots and shoes. The only objection to it for this purpose is its slipperiness when wet; for country wear, fishing boots, etc., this is no serious objection, and the remarkable imperviousness to moisture which the chromate leather shows makes it especially suitable for these purposes. For the chromate process the hides are prepared as usual, and are tanned in a bath of potassium bichromate, alum, and salt. Weak liquors are applied at first, increasing in strength in the successive pits. The tanning of heavy hides is completed in 3 or 4 weeks, while by the ordinary process 6 to 8 eight months would be required. After removing the hides from the pits, the excess of bichromate remaining in them is converted into insoluble barium chromate by immersion in barium chloride solution. After washing and partial drying, the hides are impregnated with paraffine and rosin, and are finally finished in much the same manner as those tanned with bark. It is stated that the process is inexpensive as well as rapid, and is destined in the near future to play an important part in the leather industry.

The chromate process has been described in a paper by W. J. A. Donald, published in the Journal of the Society of Chemical Industry, December 29, 1884. Tables are given in the paper showing the results of comparative tests of chromate and bark-tanned leather. The figures given show the chromate leather to be stronger by 15 per cent. than that tanned by the ordinary process.

CURRIED LEATHER.

The French exhibit included curried leathers and pigskin for harness and saddlery, of fine quality, leathers for belting, and French calfskin for boots and shoes. In the French method of currying calfskin the skins are shaved and pared on a beam, soaked and beaten in the stocks, stretched on a marble slab by means of a sleeking-iron, washed, and scoured. The skins are then dried and oiled on the slab on the grain side, generally with cod-liver oil. The flesh side is oiled with tallow and *dégras* (the oxidized refuse oil from the chamois leather manufacture). The skins are dried and whitened by paring off a thin shaving from the flesh side, and are finally coated with a mixture of oil, tallow, wax, and lampblack, followed by a sizing of glue. French calfskin is of fine quality and workmanship, and on account of the careful handwork expended in its production is superior to the product of many other countries in which the currying is effected by cheaper methods and by the aid of machinery. The most important factories are at Paris, Lyons, and in the south of France.

The French colonies exhibited specimens of serpent skin, antelope, lion, rhinoceros, alligator, and elephant hide.

The Norwegian Commission exhibited salted sealskins in the form in which they are prepared for exportation. The seals are captured on the shores of Spitzbergen, Nova Zembla, and Greenland. Their skins are used in saddlery and for bags, belts, and cartridge-pouches. Specimens of tanned *cobite* skins were also shown. These are obtained along the west coast of Norway and form the basis of a new industry, having found an important application in the preparation of morocco leather.

From Venezuela specimens of tanned skins of wild boar, tiger, kangaroo, leopard, fox, bear, and porcupine were shown.

ENAMELED LEATHER.

The French patent leather is generally of very fine quality, owing to the care expended in its manufacture. Many good exhibits of this class of products were to be seen, including patent leathers for shoes, for carriage-making, and for military uses. Among the most striking may be mentioned that of T. Sueur fils, of Paris, whose products have received high awards at many previous expositions. Fine displays of patent leather were also to be seen in the Belgian section, among which the most noticeable was probably that of Verbeckhoeven, of Brussels.

MOROCCO LEATHER.

Morocco is produced from the skins of goats, seals, and sheep. These are generally tanned with sumach, by sewing the skins into

bags and filling them with sumach infusion. The manufacture of goatskin morocco is chiefly carried on at Marseilles. The introduction of the coal-tar colors has greatly advanced the morocco industry, and has made it possible to obtain dyed leathers of beautiful tints, equal in beauty and variety to those produced upon silk. The tanning of sheepskins in imitation of morocco is largely practiced in France. Morocco is chiefly used for shoes, bookbinding, carriage-making, and for furniture. Split leathers, made by drawing calfskins and sheepskins against a knife formed of an endless band of steel, are also largely made and used for minor purposes. Goat and sheep leather are often submitted to mechanical treatment under engraved rollers, to produce imitations of alligator and sealskin. Russia leather, tanned with willow bark, was shown by several exhibitors in the Russian section. This is oiled on the flesh side with oil of birch, from which the peculiar odor is obtained, and dyed with Brazil-wood on the grain side, usually with previous mordanting with tin salts. Russia leather is largely imitated in France, Germany, and England.

TAWED LEATHERS.

The manufacture of glove-kid is chiefly a French industry, though carried on to a large extent in other countries. Fine exhibits of tawed kid and lamb's skins were to be found in the sections of France, Italy, Switzerland, and Belgium. The process of manufacture is well known, and consists in preparing the skins with lime and dung-bate, tawing with a mixture of alum, flour, salt and egg-yolks, drying, washing, stretching and dyeing with vegetable colors. The exhibits of C. Floquet et fils, Saint Denis, and Messrs. Guillou et fils, Paris, merit especial mention.

CHAMOIS LEATHER AND PARCHMENT.

Chamois leather is far less extensively manufactured than formerly. It is made from buck, sheep, and goat skins, by repeated saturation with oil and exposure to the air. The excess of oil is removed with a weak solution of potash, or by simple wringing out. Specimens of chamois leather were shown by E. H. Halley, Lefèvre-Josset, and others, of Paris, and also by exhibitors from Switzerland, Belgium, and England.

Parchment and vellum were also displayed by several firms, among which the exhibits of Frerat et Goussard, and D. Sayer, of Paris, may be mentioned, and included fine specimens of abortive vellum of beautiful quality.

XVI.—FERTILIZERS OF ORGANIC OR MINERAL ORIGIN.

The phosphoric acid required for the manufacture of fertilizers is obtained from the following sources:

- (1) Natural phosphates.
- (2) Animal phosphates, bones, guano, etc.
- (3) Phosphatic slags from the basic steel process.

In all of these the phosphorus is contained in the form of calcium phosphate, $\text{Ca}_3(\text{PO}_4)_2$, which is insoluble in water, and can serve for the nourishment of plants only when brought into solution, either by chemical reagents, or by the action of solvents present in the soil. There is a great difference in the ease with which the various forms of phosphate may be assimilated by plants; as is indicated by their behavior under the influence of mild reagents. Precipitated calcium phosphate is readily soluble in a solution of ammonium oxalate; ground bone and guano are also to a large extent dissolved, while crystallized Canadian apatite has been found to be almost wholly insoluble.

Joulié (Kolb, *Phosphates et Superphosphates*) has made careful determinations of the proportions of phosphate which may be dissolved out of various forms of calcium phosphate by ammonium oxalate; some of the results obtained are shown in the following table:

Phosphate.		Total P_2O_5 dis- solved.
		<i>Per cent.</i>
1	Neutral calcium phosphate (precipitated)	96.85
2	Guano from Guanape.....	86.66
3	Degelatinized bone.....	67.93
4	Neutral calcium phosphate (calcined).....	53.96
5	Bone-black from sugar refineries.....	43.70
6	Bone-ash.....	34.98
7	Natural phosphate (Ardenne)s.....	34.26
8	Natural phosphate, coprolite (Cambridge).....	21.84
9	Apatite from Carceres, Spain.....	13.16
10	Apatite from Canada (crystallized)	Trace.

Treatment with acetic acid yields results very similar to the above in regard to the comparative solubility of different natural phosphates. It is evident that this difference of solubility must exert a great influence upon the assimilability of these phosphates by plants, since they can only be absorbed after they have been dissolved by certain substances present in the soil, such as water charged with carbon dioxide and the acetic acid of humus. In the crude state the natural phosphates are only to a small extent assimilable; it is, therefore, usual to convert these into acid calcium phosphate (super-

phosphate) by the action of sulphuric acid, as proposed by Liebig in 1840. This practice has been of enormous benefit to agriculture in all parts of the world. Nevertheless, the ready solubility of the superphosphates in water is often a disadvantage, since it causes the fertilizer to be more or less washed away by rain, and thus lost to the plant.

Within the past few years there has been a great increase in the use of precipitated calcium phosphate, insoluble in water, such as that obtained as a by-product in modern processes of extraction of gelatine from bones. This form of phosphate is richer than the superphosphate, and at the same time equally, though more slowly, assimilable by plants. Owing to its insolubility in water it is not washed out by rain, but continues to exert its fertilizing influence during the whole period of growth, producing its full effect at the time when it is most needed, in the ripening of the grain. It may probably safely be said that the precipitated phosphate is the fertilizer of the future.*

NATURAL PHOSPHATES.

Natural deposits of apatite and other phosphate rocks are found in various parts of the world; among the most important occurrences are those of the departments of the Vosges, Ardennes, Yonne, and Rhone in France, Canada and South Carolina in America, and several localities in England, Germany, Portugal, Belgium, and Russia. The first natural phosphate exploited was the coprolite deposit of Suffolk, England, which has been worked since 1848. The bed is made up of small ovoid masses, believed to be petrified excrements of antediluvian saurians, and contains about 55 per cent. of calcium phosphate. Similar masses, called *nodules*, are found extensively in France, in the departments of Ardennes and Meuse, and have of late found important application in the manufacture of fertilizers. The total production of phosphates in France in 1888 was over 250,000 tons.

The natural phosphates, owing to the slight extent to which they are assimilated by plants, are seldom employed in the crude state, but are generally converted into superphosphates by the action of sulphuric acid. The poorer sorts, such as those of the Rhone, which contain about 40 per cent. of phosphate of lime, are now largely treated by the process of Müller & Packard, for the extraction of phosphoric acid. The ground mineral is treated with the required quantity of sulphuric acid, as in the manufacture of superphosphates; the mass is run into a vat, and, when the action is complete, is diluted sufficiently for filtration in ordinary filter presses. The clear liquor so obtained contains 7 or 8 per cent. of P_2O_5 , and is evap-

* Kolb, *Les Phosphates et Superphosphates*, Paris, 1884.

orated to a sirup. The residue in the presses is washed with water, and the washings used to dilute the strong sulphuric acid used in the decomposition to the proper degree of 53° B. The phosphoric acid obtained by this process is used in place of sulphuric acid in the manufacture of superphosphates, since by its use one equivalent of tricalcium phosphate may be converted into three equivalents of soluble acid phosphate. Very rich fertilizers, especially valuable for transportation to distant points, are thus secured.

A number of manufacturers of fertilizers from mineral phosphates were represented at the Exposition, chiefly from the departments of Ardennes, Meuse, and Somme, in the north of France. E. Berthier et Cie., St. Denis, extract 30,000 tons per year of phosphates from the mines of Orville and Beauval, and manufacture 12,000 tons of superphosphates. Paul Desailly et Cie. showed phosphates from the same localities; this firm has factories at Orville, Beauval, and many other points, and is probably the greatest producer of fertilizers in France. The mines and works of Desailly have been fully described in a work by A. Olry, engineer of mines, (Paris, Masson, 1889). T. Collat (Lille), Lefort, and others, exhibited natural phosphates from the departments of La Somme and Pas de Calais. The Société Anonyme des Produits Chimiques Agricoles, Paris, showed phosphates from Sancerrois and Lot. The phosphates of Lot are among the richest found in France, containing over 80 per cent. calcium phosphate, and have been extensively mined within a few years. The Compagnie de St. Gobain made a fine display of mineral phosphates from all parts of the world. Solvay et Cie. also exhibited superphosphates made from the natural phosphate of La Somme and Mons, of which the company make 50,000 tons yearly.

BONE PHOSPHATES.

As indicated by the researches of Joulie, ground bone may be to a great extent assimilated by plants; spent bone black, degelatinized bones, and bone ash, have also a considerable fertilizing value; these materials are, however, only to a small extent employed directly, but are chiefly converted into superphosphates and used in the form of manufactured fertilizers. The different forms in which bones are available for this purpose are the following:

- (1) Ground bones.
- (2) Bone black, the spent black of the sugar refineries which has been repeatedly washed, calcined, and reemployed until its decolorizing power is finally lost. Under this head are also included the sediment from the washings of bone black, and the blacks which have been boiled with the sirups to complete their decolorization.
- (3) Degelatinized bone; this is the residue left after extraction of the gelatine of bones in autoclaves by means of steam under heavy pressure.

(4) Bone ash; owing to the high heat to which it has been subjected, this material is far less readily assimilated than other forms of bone phosphate.

The methods employed in the manufacture of superphosphate by treatment with sulphuric acid are well known, and present few points of novelty.

An important advance in the utilization of bones, now largely practiced, is the precipitation of the phosphate from the solution obtained in the modern process of gelatine manufacture. By prolonged treatment with dilute hydrochloric acid the inorganic constituents of the bones are dissolved out, while the gelatine remains in an elastic semi-transparent form. On adding milk of lime to the solution a voluminous precipitate is obtained, which consists of tri-calcium phosphate and di-calcium phosphate (reverted phosphate). The proportion of these constituents varies with the temperature, quantity of lime, and other conditions. By means of improvements, kept more or less secret by the manufacturers, it is now found possible to so adjust the precipitation as to obtain a product containing 96 per cent. of dicalcium phosphate, soluble in ammonium citrate solution. The process of solution in hydrochloric acid and precipitation is also applied to natural phosphates; by this means the impurities contained in the mineral are largely left undissolved, and very rich fertilizers are obtained. These processes are of course only applicable in countries where hydrochloric acid is a cheap product.

Many large exhibits of animal fertilizers were to be found at the Exposition. The St. Gobain Company displayed a variety of mineral and bone superphosphates, of which 100,000 tons per annum are made at the works. Large exhibits were also made by Dior frères, Granville; the Compagnie de Rio Tinto, Marseilles; L. Salles, Paris; E. Berthier et Cie., Paris; Coignet et Cie., Lyons, and many others.

BASIC SLAG FERTILIZER.

The *basic*, or Thomas-Gilchrist steel process, introduced in England in 1879, is designed to eliminate the phosphorus from the pig-iron employed by means of a basic converter-lining, with the addition of lime to the charge. A basic slag is thus produced which contains only a small percentage of silica, and carries off about 97 per cent. of the phosphorus contained in the pig-iron. By this process it has been found possible to make excellent steel from highly phosphoric pig, and thus to utilize for steel making many deposits of ore which had previously been useless. The process has rapidly extended, and is now largely employed in England, Germany, and France. In 1886 the total amount of steel made by this process was stated to be 1,097,758 tons, with which was obtained 412,500 tons of phosphatic slag.

The basic slag contains 17 to 20 per cent. of phosphoric acid, 50 per cent. of lime, and about 14 per cent. of iron (ferrous) oxide. Its value as a fertilizer was immediately suggested and has been fully proved by careful experiments and the experience of several years of extensive use. When finely ground it is readily assimilated by plants, and has proved especially valuable for soils poor in lime and iron. The advantages of this fertilizer have been most fully recognized in Germany, where the larger part of the product finds employment. Large quantities of slag are imported into Germany from England. It is estimated that slag to the amount of over 500,000 tons was ground in Germany in 1888. It has been found that the new slag fertilizer, when used in connection with Chili saltpeter, produces the same results as ground bone and guano at a far lower cost.

The basic process is worked extensively in France, and was illustrated at the Exposition by the exhibits of the following establishments: Aciéries de Creusot (Schneider et Cie.); Forges et Aciéries du Nord et de l'Est, Jarville, near Nancy, and Valenciennes (Nord); Forges de Pompey, Mr. Fould-Dupont (Meurthe et Moselle); Aciéries de Longwy, Mont-Saint-Martin (Meurthe et Moselle).

The Aciéries du Nord produce daily 40 tons of slag phosphate ground to the fineness of flour and passed through a sieve of 0.17 millimeter. The production of the Aciéries de Longwy is given at 60 tons per day.

Full information in regard to the use of basic slag phosphates as fertilizers may be found in the following valuable works lately published:

Études Agronomiques, Grandeau (director of the experiment station at Nancy), Paris (Hachette).

Essais sur l'Assimilabilité de l'acide phosphorique des scories de déphosphoration. Peterman (director of the experiment station at Gembloux), Brussels (Weissenbrück).

Wagner, Dr. P., Superphosphat nach Thomasschacke, Darmstadt, 1889.

Wagner, Dr. P., French translation, by Giesecker, Paris (Gauthier-Villars).

PART OF SIXTH GROUP.

CHEMICAL LABORATORIES, PRESERVATION OF WOOD,
HYGIENE AND PUBLIC CHARITIES.

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CONSTRUCTION OF CHEMICAL LABORATORIES.

By W. H. CHANDLER, Ph.D.

It is proposed to reproduce here the plans and descriptions of a few of the chemical laboratories recently erected in the United States, together with those of the Polytechnical School at Zurich, Switzerland.

The chemical laboratories of the Lehigh University, the Massachusetts Institute of Technology, and the Zurich School are specially intended for instruction in technical chemistry, or, as Professor Drown expresses it, to prepare students for actual work in connection with manufactures based on chemical principles.

The descriptions and plans of the Kent Laboratories are furnished by Mr. F. A. Gooch, professor of chemistry in Yale College; those of the Lehigh University by the writer of this article. Dr. Thomas M. Drown, professor of chemistry in the Massachusetts Institute of Technology, supplied the plans and description of the laboratories of that institution, and Spencer B. Newbury, professor of chemistry at Cornell University, the plans of the laboratories there. These institutions all exhibited at the Paris Exposition of 1889, and received various recognitions from the jury. The description of the Zurich laboratories is condensed from the official description, from which the plans were also obtained. The writer desires to thank the above-named scientists for their courtesy in supplying this material.

THE KENT CHEMICAL LABORATORIES OF YALE COLLEGE, NEW HAVEN, CONNECTICUT.

(With 8 plates.)

The Kent Chemical Laboratories of Yale College, the gift of Mr. Albert Emmet Kent, an alumnus of the college, were built during the year 1887-'88, at a cost of \$75,000, according to plans elaborated by Mr. E. E. Raht, architect, from sketches by Mr. F. A. Gooch, professor of chemistry.

Located centrally in the city upon valuable land, the building was

planned with a view to securing the greatest possible compactness consistent with suitable provision for apartments abundantly lighted, adequately ventilated, easily accessible, properly connected, and of size and shape adapted to the special purposes for which they were intended. The plan which was fixed upon, and which is shown in the general view of Plate I, the floor plans of Plates II to IV, and the section of Plate V, secures for the three large laboratories the advantages so much sought in modern laboratory edifices, and usually attained by the addition of wings to the main structure; namely, lighting upon three sides, rooms not too wide to permit the perfect illumination of the central spaces, and abundant wall surface for the proper distribution of draft chambers and ventilating flues. The structure covers approximately 6,500 square feet of surface, and is finished in three stories, including the basement, the space above the third floor remaining in the rough and utilized for storage only. The actual available floor space amounts to not far from 16,000 square feet.

The outer walls of the building are of durable sandstone and the inner walls and partitions of red brick. The floors, ceilings, and the woodwork in general, are of yellow pine, with the exception of the tops of the tables in the laboratories, which are of oak. In the laboratories proper, felting is laid upon the under floor, and upon this is spread an inch of asphalt. The building is heated by steam drawn from the central boilers, which furnish the means of heating to nearly all the university buildings. Flues for ventilating purposes, lined with terra cotta pipe of square section, are built into the walls wherever it is possible to place them. The windows are large and movable at top and bottom. Provision has been made for connecting all flues with an exhausting fan in the tower, but thus far the natural draft of the flues, aided only by the warm air thrown into them from steam coils, has proved adequate to ventilate the rooms, and the exhausting apparatus has not been established.

FIRST FLOOR.

The arrangement of the first floor is given in Plate II, the rooms being so assigned that the great body of students find their places upon this level without climbing or descending stairways. The lecture room, shown in Plates II and VI, measures 42 feet in width by 38 feet from front to back, by 19 feet in height at the maximum and 14 feet from the highest level to which the inclined floor rises. It contains approximately 26,000 cubic feet of air. Seats are arranged at present for one hundred and sixty-eight individuals, but a reserve which would raise the seating capacity to one hundred and ninety can be introduced without crowding inconveniently. The room is lighted by six windows (5 feet 4 inches by 9 feet 7 inches), three at the side and three at the back. The main entrance is directly from

the hall and at the lowest level. A second door way opens between the lecture room and the preparation room, and still another gives access to the private laboratory above and to the furnace room and workshop below. The room is heated chiefly, and at the same time partly ventilated, by the introduction of the external air over steam radiators placed beneath the sloping floor, and this indirect system is reënforced by two radiators in place at the rear, and at one side, of the lecture table. The air finds exit through flues near the ceiling at front and back and through the draft-chamber flues which open also near the floor. The seats are folding chairs of modern pattern, suitably shaped to the figure of the occupant. Fixed writing-tablets are not used in this room, but when the need for such arises, portable lap-tables are made use of. The lecture table is 3 feet 6 inches wide, 22 feet long, and 2 feet 6 inches high, covered with oiled soapstone, and provided with a large pneumatic trough, and fittings for the supply of gas, water, steam, compressed air, oxygen, hydrogen, vacuum injector-pumps, and for drainage. The gas is controlled from the lecturer's side of the table, though the nipples are on the front edge of the table with other fittings, excepting the large taps for the gas supply for furnace work which are concealed below the inner projection of the table top. The table is also provided with a downward draft opening through a register plate set into the soapstone. The surface of the soapstone is excavated so as to leave a rim about the edges and about the draft register to prevent the escape of mercury or other liquid which may chance to be spilled. The floor back of the lecture table is of asphalt. On the wall behind the lecture table is the large draft-chamber, 2 feet 4 inches wide by 12 feet in length, provided with two flues. The bottom of the chamber is a soapstone table which is sufficiently raised above the level of the lecture table to permit of its being used for purposes of demonstration when the necessity for handling disagreeable or unwholesome vapors and gases occurs. In the draft-chamber is a porcelain sink provided with hot and cold water. The flues of the draft chamber are finished to the floor and closed by valved register plates. On either side of the draft-chamber are sets of drawers for the ordinary tools and smaller supplies necessary in the lecture work, and above the drawers are shelves for a small suite of specimen bottles. Permanent slate blackboards are set on the oblique walls at the sides of the table, and movable boards may be set up, as occasion requires, against the front of the draft-chamber.

The preparation room immediately adjoining the lecture room is fitted with sink, tables, shelves, etc., and communicates by stairway with the apparatus room above, and by elevator with the latter room and with the distributing room below.

The laboratory for inorganic chemistry, shown in Plates II and VII, opens directly from the hall, measures 40 by 39 by 17 feet, and

affords accommodation for thirty-six students working at one time. Three large tables of yellow pine with oak tops are divided into working spaces 3 feet 10½ inches by 2 feet 6 inches. Every place is provided with two suites of apartments for apparatus, each consisting of two drawers and a cupboard, so that it is possible to introduce two sets of students into the laboratory at different hours, each student having his own apparatus under lock and key. The drawers are locked by a lever in the cupboard and the key to the latter therefore controls all. The master key is in the hands of the instructor in charge. Through each table run aisles longitudinally and transversely. Upon one wall of the former are hung the pipes for gas supply and drainage. For making trivial repairs these aisles provide adequate passage, and when the need of extensive alteration is apparent it is possible, by loosening screws, to remove the entire backs of the cupboards on the side of the aisle opposite to that upon which the piping is fastening and so permit the opening of space enough for the use of proper tools, without disturbing the arrangement of the table or room. At each end of the table are a porcelain sink, water supply faucets of the goose-neck pattern, and injector vacuum pumps. Intermediate places are adjacent to bowls set in the table, each student having access to one faucet and one filter-pump. In the spaces at the ends of the tables and in the aisles under the bowls the waste jars stand unobtrusively. Gas is supplied through fixtures arranged along the central portion of the tables at the back of the working spaces, but the controlling cocks are along the front, just under the overhanging edge of the table top. This arrangement permits the utilization of wider space, inasmuch as the control of the gas is accomplished without the interference with apparatus upon the table and without inconvenient reaching. Instead of the ordinary retort and filter stands, the supporting rods for the iron rings of the former and the porcelain-lined rings of the latter are screwed securely into brass sockets set in the wood and flush with the surface. Thus held the rod is firm, while easily removable, and the level space about the rod permits a more advantageous disposal of apparatus than is possible when the rod is held in a movable platform. Two shelves hold reagent bottles for the common acids, ammonia, and ammonia salts, the remaining reagents being relegated to shelves in the embrasures of the windows. Distilled water is supplied in tubulated bottles which stand upon the ends of the shelves, with the glass stop-cocks overhanging the sink. Sponge racks hang underneath these stop-cocks. The side tables—which are used for miscellaneous purposes, such as the working of glass, the display of processes in operation, which demand apparatus too large or too complicated for individual use, the exposition of specimens, and, in general, for the many purposes for which space is so desirable in a laboratory—consist simply of soapstone slabs resting upon

open frames fixed to the walls and supported on wooden legs. Upon the soapstone tables at convenient points, as shown in the plan, are set the draft chambers. The construction of the latter is as simple as possible. Glazed sashes sliding in grooved frames on all sides, hung to weights in front, and inclined on top, are the essentials. The flues which ventilate the draft chambers, are continued to the floor and closed by ordinary valved registers, so that in case the draft is sluggish the heat from the steam pipes placed against the walls beneath the tables may be thrown directly into them until proper action is set up. These openings near the floor aid materially, when the draft chambers are not in use, in the ordinary ventilation of the room. Two sinks under the draft chambers at the end of the room are supplied with water, hot as well as cold, and serve for the emptying of liquids which evolve disagreeable or dangerous vapors or gases. The elevator for the transportation of apparatus communicates with this room. The floor is of asphalt (laid upon felting which rests on the wooden floor), and in it are set blocks of locust wood which afford a solid bearing, reaching to the under floor, upon which to rest the tables, thus avoiding the danger of the gradual sinking of the latter into the asphalt. Cast-iron pipes convey away the drainage of this room. After passing the floor they are hung to the ceiling of the room beneath. Every joint and length of pipe is perfectly accessible. The asphalt is finished up smooth and close against the pipe which pierces the floor. The windows of this room are $5\frac{1}{2}$ by 12 feet in dimensions and open at top and bottom.

The wardrobe and preparation room adjoin the general laboratory. The purposes of these rooms require no description, and the general arrangement is obvious.

SECOND FLOOR.

The arrangement of the apartments upon the second floor is exhibited in Plate III. The laboratory for analytical chemistry, shown in perspective in Plate VIII, is devoted chiefly to the branch of study for which it is named. But it is intended that this room shall also offer facilities for work to advanced students engaged in inorganic research. The dimensions of the room are 40 by 39 feet by 17 feet 6 inches. The general features of the laboratory beneath it, and already described, are repeated, excepting that the tables are designed for four individuals each, and each student has direct access to a large porcelain sink provided with water supply and vacuum pumps. The side tables are covered with soapstone, as in the laboratory for inorganic chemistry, and are provided with gas fixtures and movable rods. Shelves at either side of the window frames hold such of the reagent bottles as can not stand conveniently upon the individual tables. Tool boxes, blast lamps, and burners for working glass are placed in two of the opposite corners on the side tables. The draft

chambers are patterned after those already described. The floor is of asphalt. The elevator way gives direct communication between this room and the room from which the apparatus is distributed. The windows are $5\frac{1}{2}$ feet wide, and the sliding sashes measure rectangularly 8 feet from top to bottom, with a semicircular sash on hinges opening inward above, giving an entire height of 10 feet 8 inches to each window. The laboratory provides working places 4 feet $7\frac{1}{2}$ inches by 2 feet 6 inches for twenty-four students, and inasmuch as the suites of apparatus in the individual tables are duplicated, forty-eight students may be accommodated in two sections working at different times.

The balance room opens directly from the laboratory and communicates on the other sides with the private room, or preparation room, of the instructor in charge of the adjoining laboratory.

The small lecture room, private office, and private laboratory (the latter communicating by private stairway with the large lecture room, furnace room, and workshop below), the apparatus room, and library call for no description. The purpose of the last is to contain only such books and journals as are immediately needed in the work of the laboratory, the building of the University Library being immediately adjacent.

BASEMENT FLOOR.

The basement is occupied as indicated in Plate IV. The laboratory for organic chemistry measures 40 by 39 feet by 12 feet 6 inches, and is fitted in general like the laboratory for analytical chemistry on the second floor. The sinks, however, are of iron instead of porcelain, and the bottoms of the draft chambers are sinks instead of plain soapstone tables. The drainage for this floor is carried away in earthen pipes laid in graded trenches built in masonry, cemented, and covered with iron plates level with the asphalt floor which covers the entire basement. These trenches serve likewise as conduits for the gas and water pipes. The windows measure 5 feet 6 inches by 6 feet 8 inches. The capacity of the laboratory is for twenty-four students occupying tables 4 feet $7\frac{1}{2}$ inches by 2 feet 6 inches, or, as is preferable for work of the kind for which this laboratory is intended, for twelve students occupying table room 9 feet 3 inches by 2 feet 6 inches. Here, as in the other laboratory, provision has been made for duplicating, if need be, the working force. The balance room, preparation room for the use of the instructor in charge, toilet room, storeroom, distributing room, from which apparatus is issued to students, the furnace room, which is provided with compressors for oxygen, hydrogen, and air, and the workshop, complete the list of apartments upon this floor.

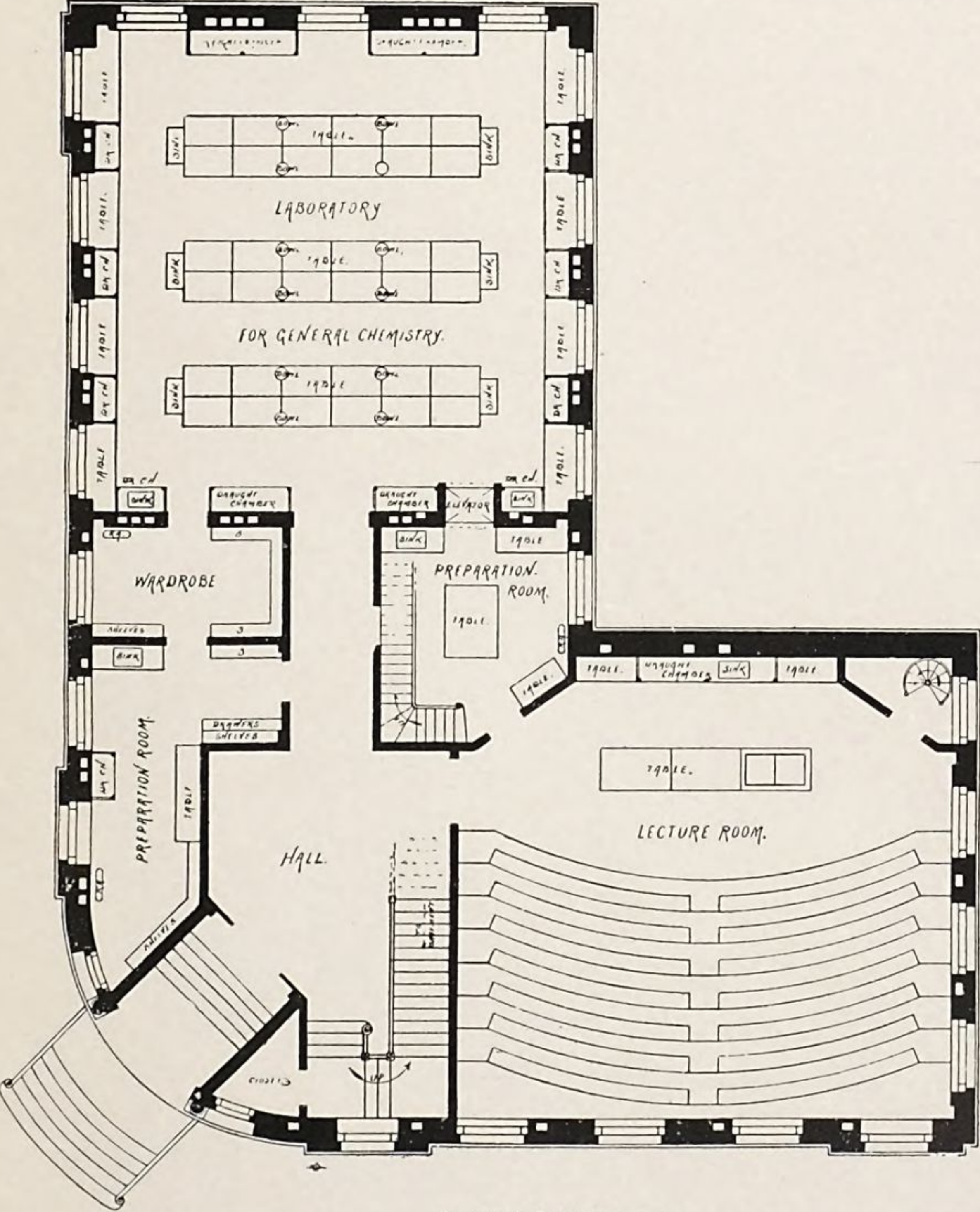
The building as it now stands can accommodate at one time seventy-two workers, or twice that number in two detachments.



THE KENT CHEMICAL LABORATORY, YAKIMA, WASH.



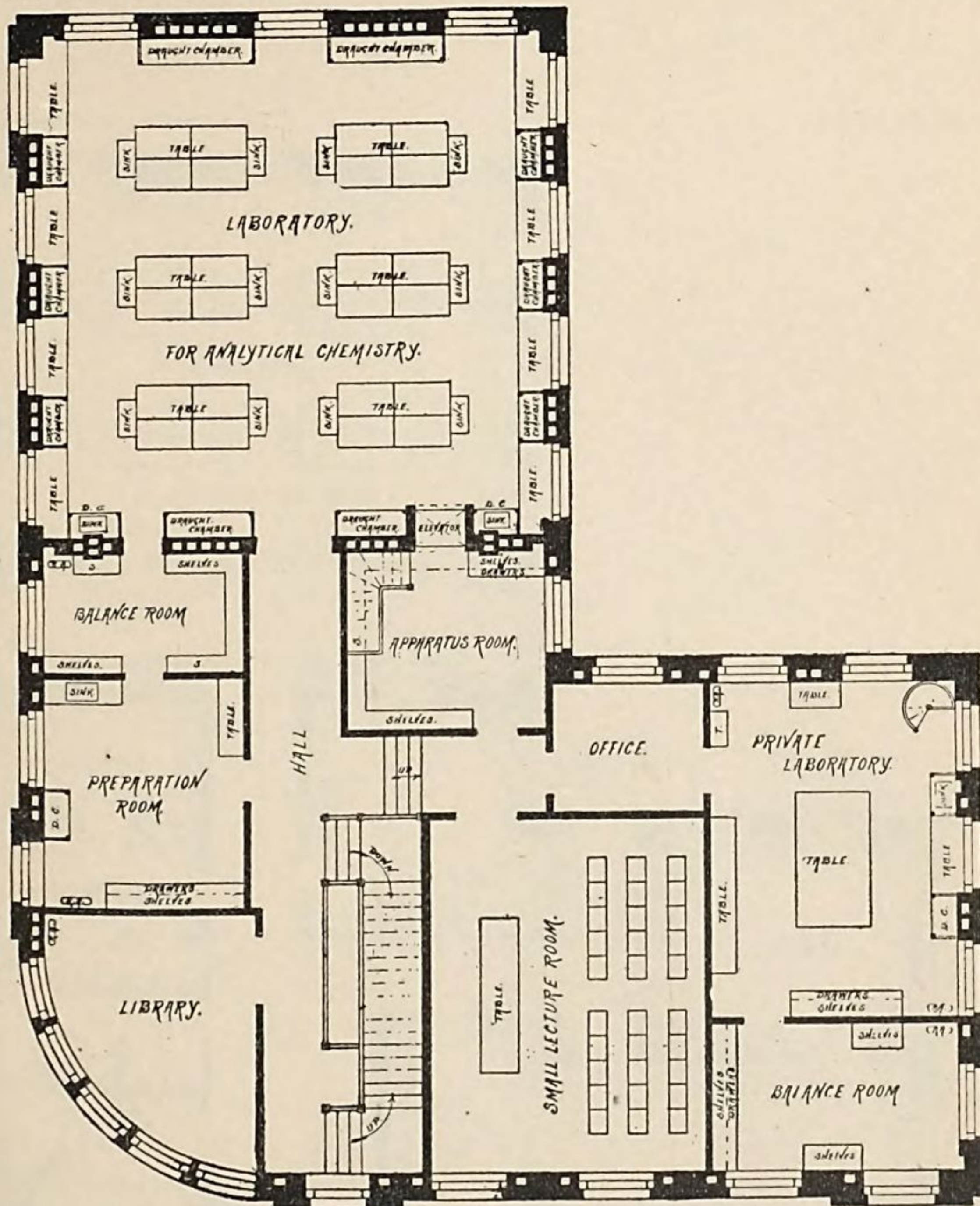
E CO LLEGE, NEW HAVEN, CONNECTICUT.



PLAN OF FIRST FLOOR

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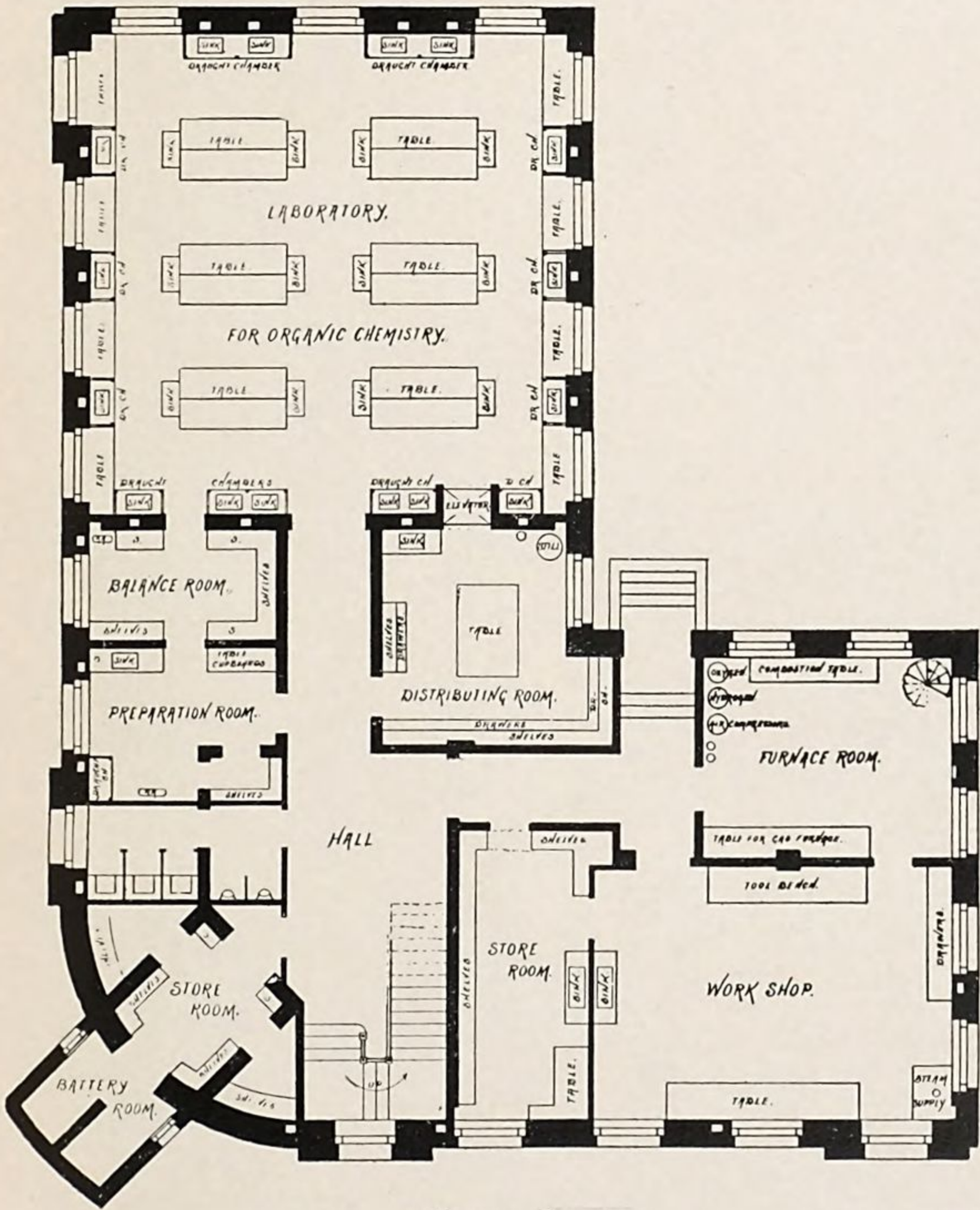
KENT CHEMICAL LABORATORY, YALE COLLEGE, NEW HAVEN, CONNECTICUT.



PLAN OF SECOND FLOOR



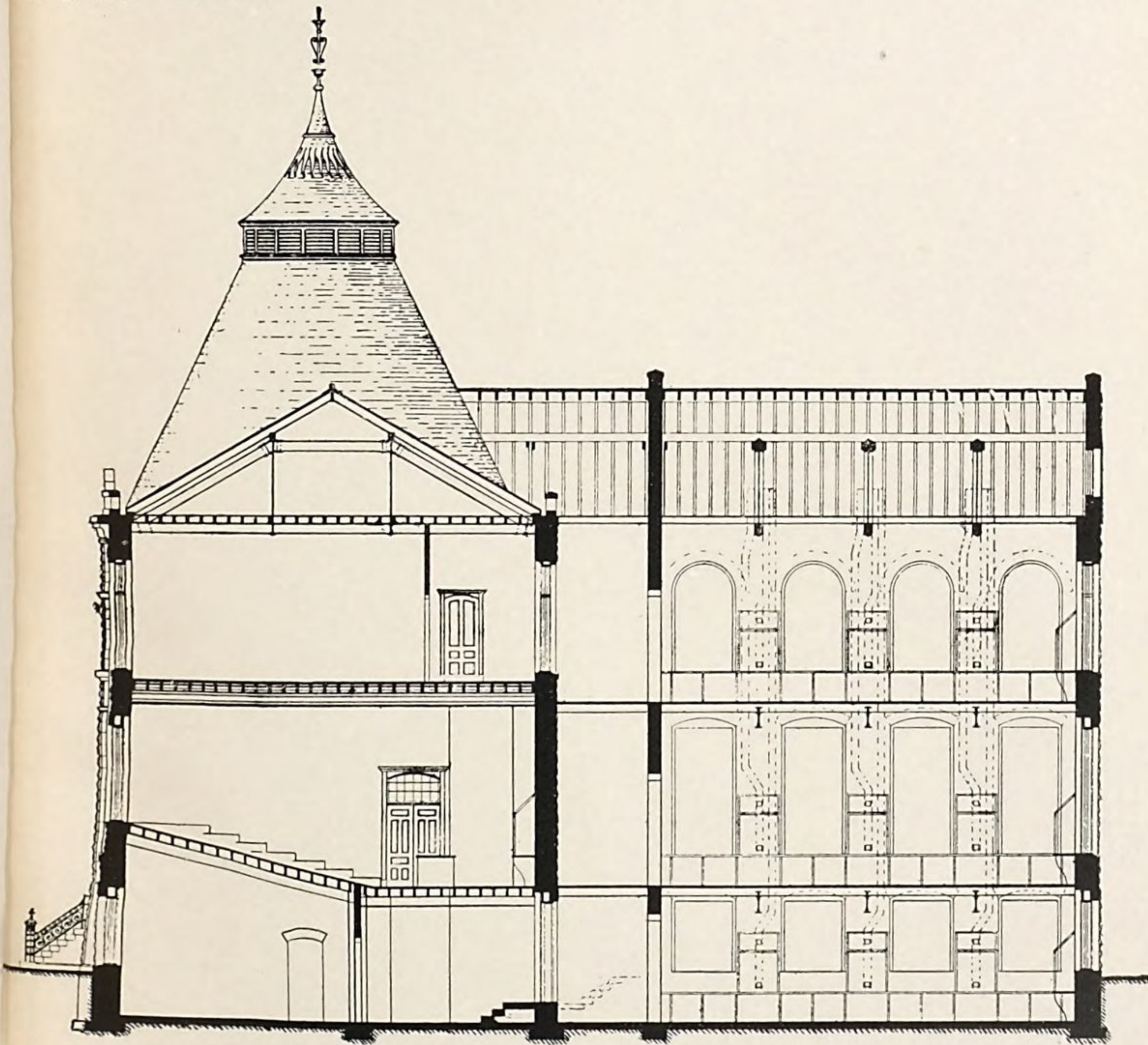
KENT CHEMICAL LABORATORY, YALE COLLEGE, NEW HAVEN, CONNECTICUT.



PLAN OF BASEMENT.

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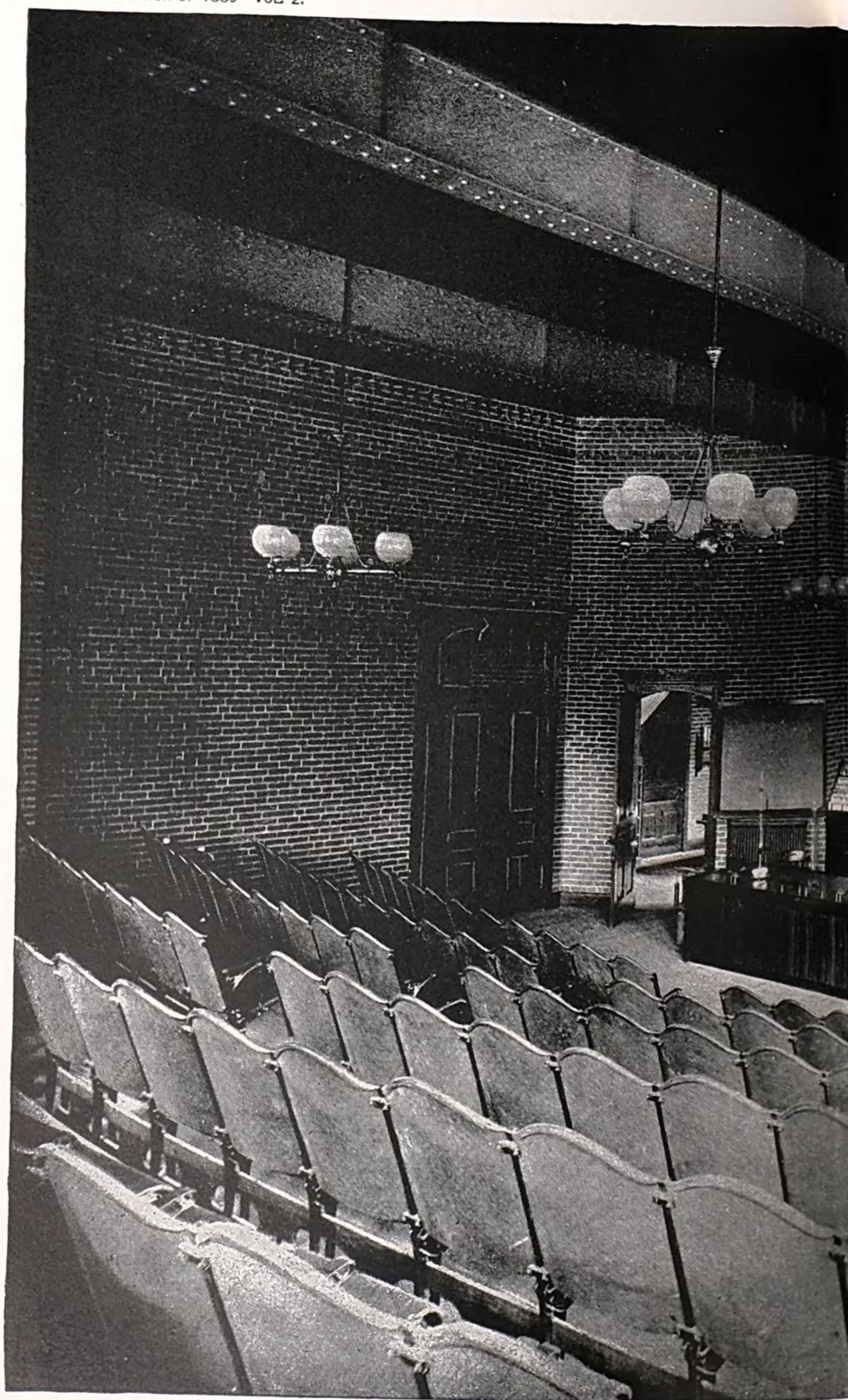
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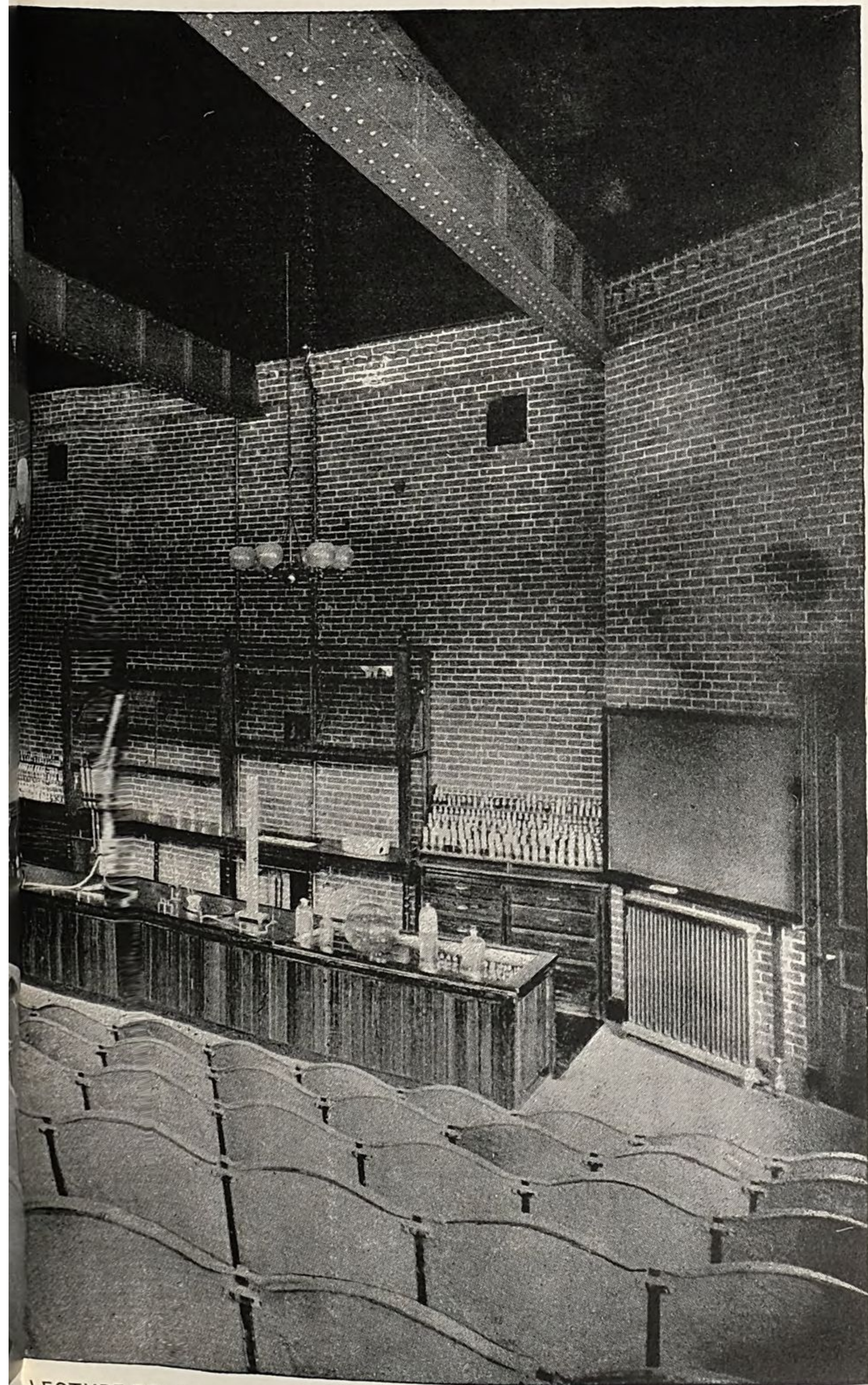


SECTION THROUGH LABORATORIES.

1/2" = 1' 0"

KENT CHEMICAL LABORATORY, YALE COLLEGE, NEW HAVEN, CONNECTICUT.

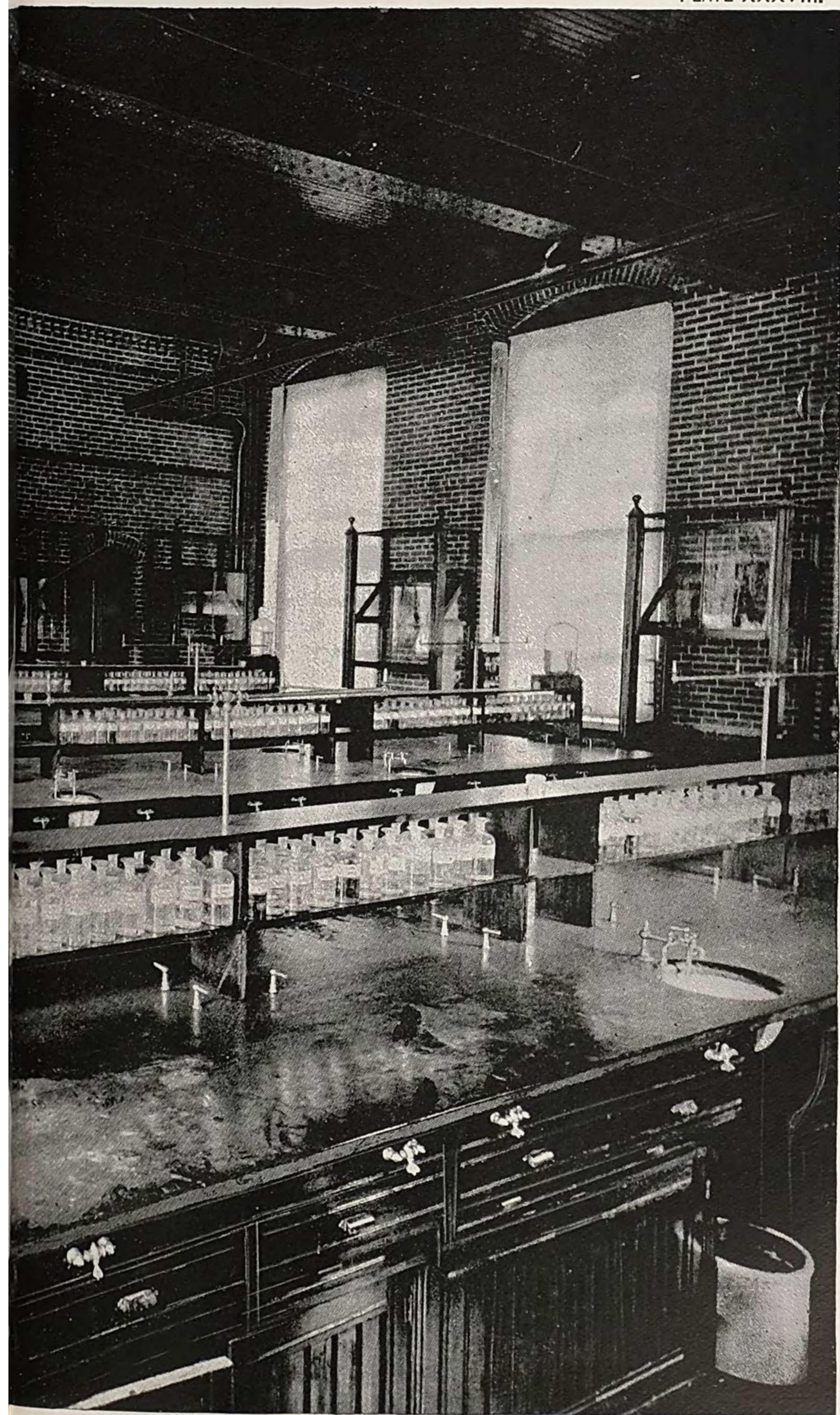




LECTURE ROOM.



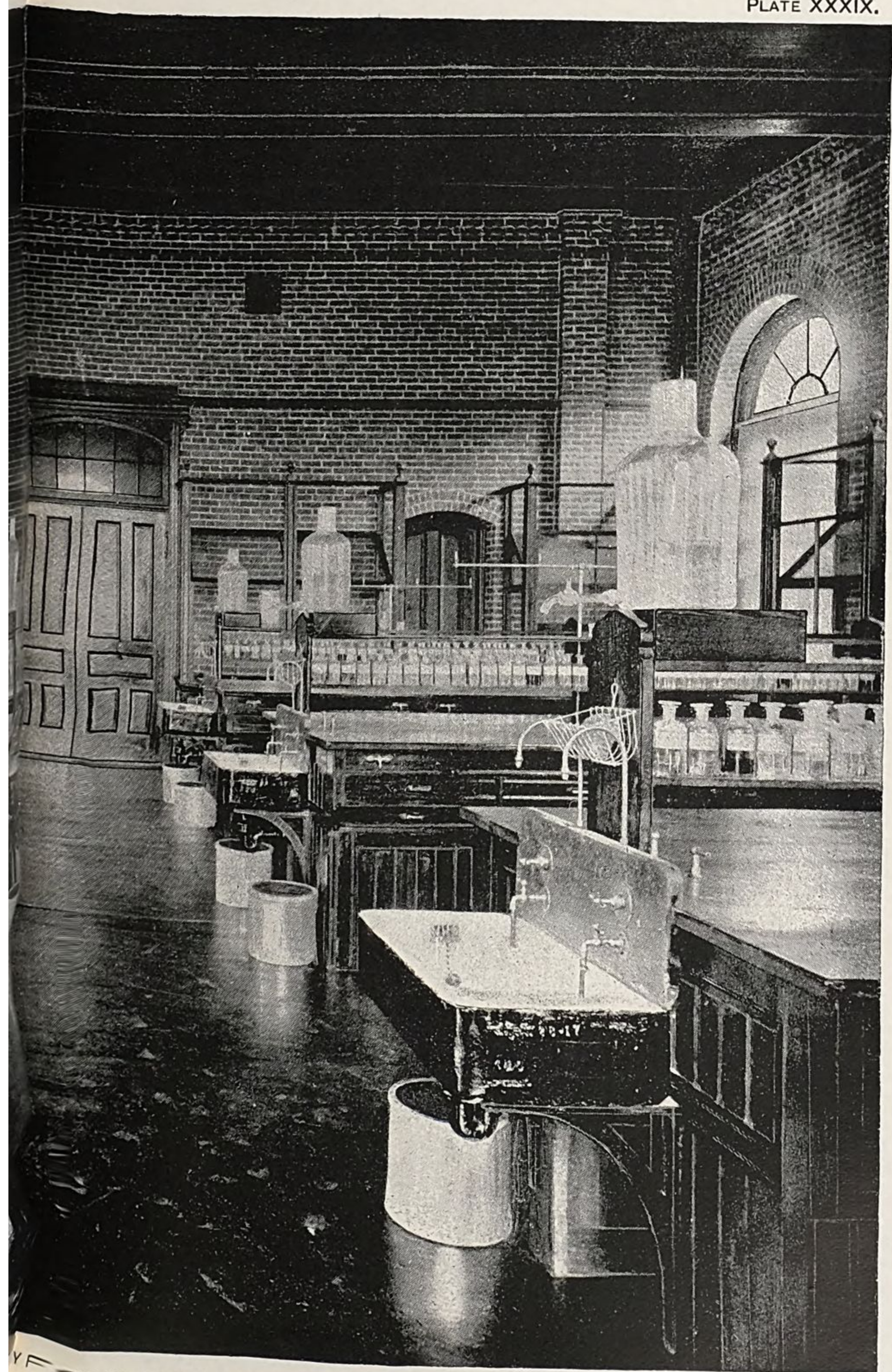
KENT LABORATORY—LABORATO



Y FOR INORGANIC CHEMISTRY.



KENT LABORATORY—LABORATO



THE CHEMICAL LABORATORIES OF THE LEHIGH UNIVERSITY,
SOUTH BETHLEHEM, PENNSYLVANIA.

(With 19 plates.)

These laboratories and their fixtures were planned by William Henry Chandler, professor of chemistry in the University, and the plans were carried out by Addison Hutton, architect, of Philadelphia. The buildings were erected between May, 1884, and September, 1885. They are situated in the University Park, on a side hill. A retaining wall upon the upper side, 11 feet away from the building, forms an area by which the daylight has access to the basement windows in that side. The building faces the north. It is built of a hard quartzite found in the neighborhood.

The main building is 219 by 44 feet, with a basement and two principal stories, the central portion, 37 feet 6 inches wide, having a third story. The wing is 50 by 84 feet, connected to the main building by a narrower structure, 37 feet 6 inches by 11 feet. The wing has two principal stories only. Between the windows are two flues, which terminate in the chimneys and serve the purpose of ventilation, a few flues being used for the furnaces in the assay laboratory.

The windows are all 4 feet wide, and are provided with transoms opening from the top. Those in the assay laboratory, including the transom, are 6 feet 6 inches high; in the gas analysis rooms 7 feet high, and the smaller windows beyond are 3 feet 6 inches high. On the first story they are 9 feet 8 inches high, except those in the lecture room and beyond, which are 16 feet high. In the second story they are 9 feet high. In the third story they are 8 feet high.

All doors are glazed so as to give light to the halls and corridors, and are also provided with transoms.

The walls of the quantitative and qualitative analysis laboratories and the main corridors are lined with white pressed Amboy bricks, with a base of four courses of brown glazed bricks and three lines of red pressed bricks; one of three courses, on the middle line of the windows, and two of two courses each, above the top line of the windows, three courses of red brick capping the windows. All the other rooms have walls finished in a light yellow so-called soapstone finish, with a base of four courses of brown glazed bricks. The soapstone finish is very smooth and hard.

The floors are of yellow pine, laid upon iron beams and brick arches, except in the basement, where the floor is North River bluestone, laid in cinders. The room for sulphureted hydrogen and the combustion room have a layer of asphaltum beneath the wooden floor.

The ceilings of rooms of the two principal stores, which are used

as laboratories, are of yellow pine, to obviate the dropping of plaster. All other rooms have ceilings with soapstone finish.

The stairways are of iron.

The heating is effected by radiators, placed in the window-jambs, below the windows, the steam being supplied from the boiler house, which furnishes the steam for all of the University buildings. One boiler is run under a pressure of 40 pounds to supply the engine and air-pump in the basement. This boiler also furnishes steam for the steam baths, the ventilating flues, and the stills.

The ventilation is accomplished by means of the flues terminating in the chimneys. No two rooms, however, use the same flue. These flues are 12 inches square, and are coated interiorly with asphaltum to prevent the disintegration of the brick by the acid vapors. In the flue is a 2-inch iron steam-pipe bent like an inverted U, 5 feet high, which accelerates the upward current of air. The opening for ventilation is placed 8 inches above the floors. They are 12 by 18 inches, and are covered by an iron grating, without valves.

Fresh air is admitted through an opening from the outside beneath each window provided with a valve. The air passes by a galvanized iron tube to the bottom of the steam radiators.

The hoods or fume closets are placed between the windows, and are ventilated by an opening 6 inches square into the same flue that the large ventilator below taps. The hoods have a window-frame, glazed, with two sliding doors in front. The top is also glazed. They are 4 feet 8½ inches by 1 foot 10 inches and 2 feet 6 inches high. The peak of the top is 4 feet 1 inch above the floor of the hood. The floor of the hood is of soapstone 1¼ inches thick, and is supported by three iron brackets. The top of this floor is 3 feet 2 inches above the floor of the laboratory. In each hood is a steam bath 1 foot 6 inches square and 4 inches high, midway is a perforated diaphragm to distribute the steam. There are nine round openings in the top of the bath, 5⅝ inches in diameter, with concentric rings to reduce the opening. The entire bath is made of copper, brazed. The steam supply pipe projects half an inch through the bottom of the bath to prevent the condensations from running into the pipes. The condensed steam runs away through a waste pipe, which terminates flush with the bottom of the bath.

There are in the hood six gas connections. A slot is cut in the bottom of each door to admit air.

The sinks are placed in the window jambs, over the radiators, 3 feet 2 inches above the floor, being supported by wrought-iron collars with arms terminating in the brickwork of the jambs. The sinks are Butler's white crockery sinks, made by the Stewart Ceramic Company, of New York; size, 37 by 22 by 7½ inches, outside measurement. There are two pantry cocks to each sink for cold water. The supply pipes for water are of galvanized iron.

The waste pipes from the sinks are of lead. They are carried to the basement, with no horizontal sections, and through the basement walls into a terra-cotta pipe. This terra-cotta pipe is trapped. The drainage from the toilet room is carried by a separate terra-cotta pipe on the outside of the building, which is also trapped. The two pipes join below the traps.

The waste pipes from the sinks were supplied with lead traps just below them. They rapidly were corroded and are not replaced when they are worn out, being found unnecessary.

All the pipes for steam, water, and drainage are carried in an open niche in the window jambs from the upper story to the basement, so as to be readily accessible for repairs. Each drainage pipe, as mentioned, passes directly through the wall into the main terra-cotta drain pipe. The steam and waste pipes are carried in a duct below the basement floor, covered with blue stone, to the main supply pipes, and are readily accessible. The steam pipes are all covered with felting and canvas. Both the steam and waste pipes are arranged so that the supply can be cut off from a portion of the building without affecting the remainder in case repairs are necessary.

DIMENSIONS OF THE VARIOUS ROOMS.

Subcellar, 38 feet by 32 feet; 7 feet high.

BASEMENT FLOOR.

DEPARTMENT OF CHEMISTRY.

Gold bullion room, 21 feet by 10 feet 6 inches; 12 feet high.

Silver bullion room, 21 feet by 15 feet 6 inches; 12 feet high.

Balance room, 21 feet by 11 feet; 12 feet high.

Assay laboratory, 66 feet 6 inches by 38 feet; 12 feet high.

Assay supply room, 16 feet 6 inches by 10 feet; 12 feet high.

Packing room, 27 feet 4 inches by 10 feet; 12 feet high.

Gas analysis room, 16 feet 6 inches by 10 feet; 17 feet high.

Gas analysis room, 14 feet 6 inches by 14 feet 6 inches; 17 feet high.

Photometer room, 14 feet 6 inches by 19 feet; sloping ceiling 17 feet to 8 feet high.

Industrial chemistry room, No. 2, 14 feet 6 inches by 21 feet; 8 feet high.

Industrial chemistry room, No. 3, 38 feet by 20 feet 6 inches; 8 feet high.

Engine room, 14 feet 6 inches by 9 feet; 8 feet high.

Toilet room, 14 feet 6 inches by 23 feet 8 inches; 8 feet high.

Coat room, 14 feet 6 inches by 32 feet 6 inches; sloping ceiling, 17 feet to 8 feet high.

FIRST FLOOR.

Organic chemistry laboratory, 38 feet by 32 feet; 14 feet 11 inches high.

Balance room, 8 feet by 10 feet; 14 feet 11 inches high.

Vestibule to last, 8 feet by 5 feet; 14 feet 11 inches high.

Physiological chemistry room, 14 feet 6 inches by 21 feet 8 inches; 14 feet 11 inches high.

Agricultural chemistry room, 14 feet 6 inches by 21 feet 8 inches; 14 feet 11 inches high.

Corridor between last two, 7 feet 6 inches wide.

Museum of chemistry, 38 feet by 33 feet 4 inches; 14 feet 11 inches high.

Recitation room, 32 feet by 16 feet 8 inches; 14 feet 11 inches high.

Preparation room, 27 feet by 10 feet; 14 feet 11 inches high.

Sanitary chemistry room, 16 feet by 16 feet; 14 feet 11 inches high.

Lecture room, chemistry, 57 feet 4 inches by 38 feet; 21 feet high to 7 feet 6 inches high on rear platform.

Apparatus corridor, 38 feet by 7 feet; 21 feet high.

Professor's office, 18 feet by 22 feet; 21 feet high.

Professor's laboratory, 19 feet 3 inches by 22 feet; 21 feet high.

DEPARTMENT OF MINERALOGY AND METALLURGY.

Wet laboratory, 17 feet 10 inches by 29 feet; 14 feet 11 inches high.

Blowpipe analysis room, 25 feet by 29 feet 11 inches; 14 feet 11 inches high.

Dry laboratory, 18 feet by 29 feet 11 inches; 14 feet 11 inches high.

Instrument room, 18 feet by 15 feet 11 inches; 14 feet 11 inches high.

Packing room, 18 feet by 12 feet 3 inches; 14 feet 11 inches high.

Corridor, 5 feet 11 inches wide.

SECOND STORY.

DEPARTMENT OF CHEMISTRY.

Combustion room, 15 feet by 11 feet 8 inches; 16 feet high.

Balance room, 15 feet by 13 feet 8 inches; 16 feet high.

Library, 15 feet by 11 feet 8 inches; 16 feet high.

Corridor, 5 feet by 38 feet; 16 feet high.

Quantitative analysis laboratory, 67 feet by 38 feet; 22 feet high in center, arched to 16 feet high at side walls.

Instructor's laboratory, 16 feet by 16 feet 8 inches; 15 feet high.

Instructor's laboratory, 16 feet by 16 feet 8 inches; 15 feet high.

Qualitative analysis laboratory, 70 feet by 38 feet; 22 feet high in center, arched to 16 feet high at side walls.

Sulphureted hydrogen room, 7 feet 6 inches by 38 feet; 22 feet high in center, arched to 16 feet high at side walls.

Supply room, 10 feet 6 inches by 27 feet; 15 feet high.

Supply room, 16 feet 6 inches by 16 feet; 15 feet high.

Industrial chemistry room, No. 1, 20 feet 6 inches by 16 feet; 15 feet high.

DEPARTMENT OF MINERALOGY AND METALLURGY.

Lecture room, 20 feet 2 inches by 28 feet 11 inches; 15 feet high.

Museum, 44 feet by 29 feet 11 inches; 15 feet high, 22 feet high in center.

Study, 16 feet 2 inches by 11 feet; 15 feet high.

Mineralogical laboratory, 16 feet 2 inches by 17 feet 6 inches; 15 feet high.

Corridor, 6 feet wide.

THIRD STORY.

DEPARTMENT OF CHEMISTRY.

Still room, 10 feet 8 inches by 22 feet 6 inches; 14 feet high.

Photography room, 32 feet by 16 feet 4 inches; 14 feet high.

Dark room, No. 1, 10 feet 8 inches by 15 feet; 14 feet high.

Dark room, No. 2, 10 feet 4 inches by 10 feet 4 inches; 14 feet high.

The floor area of the building is 34,000 square feet, of which the chemical department occupies 24,000 square feet, the mineralogical and metallurgical department 5,000 square feet, and the balance pertaining to the corridors. The cost of the building and fixtures was about \$200,000. In the chemical department there are tables for one hundred and ninety-eight students; by dividing the classes in qualitative analysis and assaying, three hundred and eighteen students can be accommodated.

DESCRIPTION OF THE ROOMS.

DEPARTMENT OF CHEMISTRY.

BASEMENT.

THE ASSAY LABORATORY.

This laboratory has a floor of blue stone. Below it is a subcellar for fuel and ashes. A lift is provided for elevating the iron wagon for fuel.

There are twenty-nine small and two large crucible furnaces, and provisions for twelve muffle furnaces. The small furnaces are 10 by 10 inches, and the large furnaces 1 foot 6 inches by 1 foot 6 inches interior dimensions. Some of the small furnaces are built in blocks of four, the exterior dimensions of which are 5 feet 7 inches by 5 feet by 2 feet 9½ inches high, above level of floor. They are built of ordinary brick, faced with pressed brick, and the furnaces and flues

lined with the best fire brick. An airspace of an inch separates the fire brick lining for the red brick, and obviates the expansion of the outer portion of the block. No binding rods are necessary if this construction is followed. The flues from the four furnaces are led to one chimney flue, 12 by 12 inches. The block is covered by a cast-iron plate 0.75 inch thick, with an overhanging ledge and openings corresponding to the furnaces, but 4 inches larger in both dimensions, so as to remove it from the high heat of the furnace and obviate cracking. A cast-iron collar 4 inches wide is fitted into each of these openings, the inner line of the collar corresponding with the inner line of the furnace. This protects the lining from chipping by contact with the furnace tools. A cast-iron frame, holding a piece of soapstone $1\frac{1}{4}$ inches thick, and provided with wrought-iron handles, covers the furnace. A wrought-iron damper is placed in the flue to each furnace, and through the side of the furnace below the grate is an opening, 4 inches in diameter, and closed by a sliding damper, to admit air and obviate back draft. The grate of the small furnace is 10 by 10 inches of cast-iron, in one piece, hung at the back by two lugs; in front it is supported by an iron pin thrust through the side of the furnace, the withdrawal of which permits the grate to swing downward and deliver the ashes into the ash bins below.

The pipe from each muffle leads into a main flue 12 by 12 inches, passing horizontally over the furnaces, and this connects with a chimney flue of the same size; this main flue has a slight ascent. In order to insure a good draft two dampers are placed in the pipe from each muffle furnace, one a close-fitting damper, to be closed when there is no fire in the furnace, the other, a loose damper with an opening in the center, to be used when there is a fire in the furnace, but not in use; this permits the escape of the coal gas without materially influencing the draft of the other furnaces. The ash bins in the subcellar are of brick, with iron doors below for emptying them, and openings near the ceiling to admit air to the furnaces, a cold air duct from the outside admitting air to the cellar.

The draft to all the furnaces is excellent.

The large furnaces are similarly constructed, excepting the cover, which is in two pieces, and also the grate, one-half of which is secured in place by two lugs on each end and the other half has one lug on each end upon which it swings and two movable pins in front. The two large furnaces are connected by flues with one chimney flue 12 by 12 inches.

The muffle furnaces are placed upon a cast-iron shelf, 1 inch thick, 2 feet $5\frac{1}{2}$ inches wide and 2 feet 9 inches above the floor, and supported on brickwork. This plate has an opening, corresponding to each furnace, to permit the ashes to fall to the ash bins in the subcellar. There is a double row of muffle furnaces, six in a row, with

a passage between the rows, to permit the feeding of the furnaces with the fuel, half coke and half anthracite, chestnut size. In front of the muffles is a brick wall, with small openings, to give access to the muffles. The muffles thus face the light, and the brick wall protects the analyst from the heat. Six muffles communicate with one chimney flue 12 by 12 inches.

The working tables are six in number, 12 by 5 feet by 3 feet 2 inches high. They are of white pine with soapstone tops $1\frac{1}{4}$ inches thick. A bottle rack is placed through the center longitudinally, the lower shelf of which is sufficiently above the table to allow the horn scales to swing from a hook attached thereto. Each desk accommodates six students. It is provided with drawers and closets for twelve students, so that by dividing the class into sections the laboratory will accommodate seventy-two students. The doors to the closets slide longitudinally, and by a bolt attachment lock the drawers above.

The table for the balances in the balance room consists of a slate slab 3 feet wide, 2 inches thick, supported upon brick piers. It is 4 feet $1\frac{1}{2}$ inches above the floor.

The silver bullion room is provided with a slate shelf on either side 2 feet wide, 3 feet 2 inches above the floor, $1\frac{1}{4}$ inches thick, and a slate backing against the wall 2 feet high. Five small wooden shelves on either side, 4 feet above the shelf top, support the bottles for the salt solution. Ten students can thus work here at once. The steel rolls and bottle shaker are placed in this room.

The gold bullion room has a soapstone shelf 1 foot 6 inches wide, $1\frac{1}{4}$ inches thick, and 2 feet above the floor.

Gas attachments are placed above the shelf. The parting of gold and silver is conducted here.

The assay supply room is fitted with adjustable shelves, and contains the various chemicals, apparatus, and test samples of ores for use in the assay laboratory.

THE GAS ANALYSIS ROOMS.

Each of these rooms contains a table, consisting of a slate slab $1\frac{1}{2}$ inches thick, 4 feet 3 inches by 2 feet 10 inches, 2 feet $7\frac{1}{2}$ inches above the floor, and supported upon two brick piers. A thin strip of walnut is fastened around the edge, projecting above the table 1 inch, and made mercury-tight by glue. Two iron rods are secured to each table, to which the arms are attached which support the eudiometers, etc. The mercury troughs are of wood with glass sides. Two students can work at each table. Two small brick piers with slate tops support the cathetometers.

THE PHOTOMETER ROOM.

Contains a Bunsen photometer, a graduated gas tank of 10 cubic feet capacity, and apparatus for determining the specific gravity,

the ammonia, and sulphur of illuminating gas; also an apparatus for preparing mixtures of gases for analysis. This consists of inverted glass bottles, $2\frac{1}{2}$ litres capacity, secured in place in a tank of water. The neck of the bottle is closed by a rubber stopper, through which passes two bent glass tubes, through one of which water is admitted near the stopper by means of a stop-cock, and through the other, which extends the length of the bottle, the gas is forced into a measuring tube. Mixtures of known composition can thus be prepared for analysis by the students.

The following gases are used: Hydrogen, nitrogen, oxygen, carbon monoxide and dioxide, methane and ethene.

INDUSTRIAL CHEMISTRY ROOM, NO. 2.

This contains a working model of a gas works, capable of distilling 5 pounds of coal. It consists of a cast-iron retort, condenser, scrubber, purifier, meter and holder, the latter 50 cubic feet capacity. There is also a working model of an alcohol still, with doubler, condensers, and mashtubs; the still has a capacity of 12 gallons. Finally there is a working model of a sugar refinery, with blow-up, bag filters, coal filters, vacuum pan, and pumps and centrifugal. The pan has a capacity of 10 pounds of sugar. This apparatus is for practical experiments in these subjects.

INDUSTRIAL CHEMISTRY ROOM, NO. 3.

This contains machinery and apparatus for pulverizing samples of ores. Apparatus for dyeing, calico printing, bleaching, and the manufacture and purification of chemicals, is placed here.

ENGINE ROOM.

This contains an 8 horse-power steam engine, made by the Safety Steam Power Company, to drive the machinery in the last-named room.

Here also is an air-pump, size 8x10x15, made by the Cameron Steam Pump Company, of New York. This pump is connected with two wrought-iron cylinders, 6 by $2\frac{1}{2}$ feet diameter, in one of which a partial vacuum is maintained and in the other a pressure of air. The vacuum cylinder, with about 10 pounds vacuum, is connected by lead pipes to vacuum cocks upon all the working tables in the building. Each vacuum cock has four attachments, which was made by F. F. McGann, Boston, Massachusetts. A solution of caustic soda is placed in the vacuum tank to neutralize any acid vapors that may be drawn downward from the filtering flasks.

The pressure cylinder, about 8 pounds pressure, is similarly connected, with exit cocks in certain parts of the building, for use in blast lamps.

The packing room contains the carboys of acids and a brick fire-proof, 5 feet 9 inches square and 10 feet high, to receive the dirt and rubbish of the building. A brick chute passes up through the building for this, with an iron door on each floor, and connected with a chimney above.

The coat room contains four blocks of coat boxes for the coats and hats of students.

The toilet room contains the usual conveniences.

A merchandise elevator passes from the basement through the preparation and general supply room to the upper story.

FIRST STORY.

THE ORGANIC CHEMISTRY LABORATORY.

In this laboratory are tables for twenty-two students, 5 feet wide by 3 feet 2 inches high, allowing a space of 6 feet by 2 feet 6 inches table top for each student. These tables or desks have soapstone tops $1\frac{1}{4}$ inches thick, as have all the tables in the building, upon which gas burners are used; experience has shown that these tops are very durable, do not crack with heat, and are little affected by chemicals, concentrated sulphuric acid affecting it only slightly. When heat is not used slate tops, on account of their lesser cost, are preferred. In our old laboratory it was found that slate tops were badly cracked by the heat reflected down from evaporating dishes, etc. The soapstone came from Vermont and cost 80 cents per square foot; the slate cost 40 cents per square foot and came from Henry Kuntz, Statington, Pennsylvania. All these table tops are coated annually with boiled linseed oil.

These tables, as with all the working tables in the laboratories, are made of white pine, with sliding doors to the closets, placed below two rows of drawers, the closing of the doors forcing upward a bolt which locks the drawers and the doors being locked by a spring lock. The backs of the closets are fastened by screws and can be removed to allow access to the space of 4 inches, which intervenes between the closets on either side of a table. In this space the gas, steam, vacuum, air blast, water, and waste pipes are placed; all the tables in the organic, agricultural, physiological, sanitary, and industrial chemistry No. 1, preparation room, main supply room, and professor's and instructor's laboratories have all of these attachments.

Upon the tables in the organic, agricultural, physiological, sanitary, and industrial chemistry No. 1, there are no bottle racks.

The drying box for precipitates has the same dimensions and form as the fume closets, and has similar sliding doors. It is divided into four spaces by upright wooden partitions. There are projections of sheet copper upon which movable frames are placed of wood covered with sheet copper, which is perforated to receive funnels con-

taining substances to be dried. An iron steam coil in the bottom supplies the heat. The balance room contains a balance table on either side, 4 feet $1\frac{1}{2}$ inches high, 1 foot 6 inches wide, 2 inches thick, of slate, supported upon brick piers, resting upon the brick arches, and independent of the wooden floor and the side walls. Oxygen for combustion is preserved in a rectangular copper tank, without bottom, placed in a copper lined wooden tank. This tank has a capacity of about 10 cubic feet. The furnace for heating substances in closed glass tubes is placed upon one of the tables in this room. Distilled water is drawn from a faucet in this laboratory.

PHYSIOLOGICAL AND AGRICULTURAL CHEMISTRY ROOM.

The doors to these rooms are sliding doors, so that they may be used as an experimental lecture room.

MUSEUM OF CHEMISTRY.

The double cases are 9 feet by 3 feet $11\frac{1}{2}$ inches by 7 feet $4\frac{1}{2}$ inches high. The wall cases are 2 feet deep. The floor cases have swinging doors and the gallery cases sliding doors. There are no interior partitions, the shelves being supported upon Gavit's shelf supports secured to posts. The galleries rest upon iron arms secured to the tops of the floor cases.

RECITATION ROOM.

This is fitted with chairs with table arm, and is supplied with blackboards of slate. It accommodates forty-seven students.

LECTURE ROOM FOR CHEMISTRY.

This is provided with a stepped floor with one hundred and fifty-eight chairs with table arm. The chairs are like those designed by Dr. Agnew for Columbia College, New York. The rise in the steps is carefully calculated, so that every student has a good view of the lecture table. There are no columns in the room, the floor above being supported by two heavy wrought-iron girders.

The lecture table is 33 by 3 feet by 3 feet high. It is covered with soapstone and provided with pneumatic trough, closets, and drawers. It has gas, air blast, vacuum, water, steam, and waste attachments. To the front row of seats is 6 feet 9 inches, and between the table and end wall is a space 10 feet wide. Upon the end wall blackboards of slate extend across the room, the width being 5 feet. Above the blackboards are strips of wood with knobs, to which diagrams may be hung. The room is darkened by thick curtains sliding upon iron rods, all the curtains upon one side being drawn at once by means of cords passing over pulleys. The screen for lantern pictures consists of muslin stretched over a light wooden frame pro-

vided with brass eyes upon the top, by which it is hung upon hooks secured to the ceiling when required for use.

The lantern is placed upon a shelf in the apparatus corridor behind the lecture room, and projects the pictures through the doorway and through the screen.

The lecture room has 36,000 cubic feet of space.

The apparatus corridor in the rear of the lecture room is fitted with closets, drawers, and shelves for the lecture apparatus.

PREPARATION ROOM

Is used for preparing samples for analysis or lecture illustrations. It has distilled water faucet.

THE SANITARY CHEMISTRY ROOM

Contains the apparatus, in its cases, for such examinations as relate to sanitary matters, and has tables supplied with the usual laboratory fixtures.

SECOND STORY.

QUANTITATIVE ANALYSIS LABORATORY.

This laboratory contains working tables for forty-eight students, allowing a space of 6 feet by 2 feet 6 inches table top for each student. The tables are like those of the organic chemistry laboratory, but have bottle racks. These racks consist of walnut shelves supported upon gas pipe. A perforated iron washer rests upon the table top, upon this a section of gas pipe, upon this another washer, and on this the shelf, and so on, to the top shelf. An iron rod passes down through the shelves, pipes, and table tops, and is secured by nuts at either end, thus bolting the rack firmly to the table and forming a rack, which is not in the way and which intercepts very little light. On the under side of the table top a piece of flat iron 2 inches broad and of a length equal to the width of the rack is placed above the nuts to give greater firmness. The tables are placed 5 feet apart. The end of the table is 15 feet 7 inches from the wall, and the main aisle is 6 feet 11 inches wide. The tables are placed opposite the windows, so that the light may come in front of the students. They are supplied with gas and vacuum attachments only, each student using four gas and two vacuum openings. The tables rest upon the brick arches, the floor being laid between them, so that it may be removed without moving them. A drying box for precipitates similar to that in the organic chemistry laboratory is provided here; also a hot box for driving off hydrochloric acid, etc., in which a temperature of 110° is attained. This is a closed wooden box 1 foot deep and of the superficial area of a fume closet, in one of which it is placed. Two copper steam coils, one above the other, supplies the heat, and a perforated copper plate resting upon the upper coil sup-

ports the dishes. Wooden covers in the box give access to it. Distilled water is supplied by two faucets in this room. This laboratory has 51,000 cubic feet of air space.

THE BALANCE ROOM.

The central balance table is 3 feet wide, and the side tables 1 foot 7 inches wide and 4 feet 1½ inches high. They are of slate, 2 inches thick, and rest upon brick piers placed upon the brick floor arches and independent of the wooden floor and the walls. The room is lighted by end windows as well as a skylight. The number of balances is eleven.

The combustion room is fitted with soapstone tables, around the sides, with gas, air blast, and vacuum attachments. An oxygen tank, like that in the organic chemistry room, is also provided. This room is for such combustions and fusions as are necessary for the course of inorganic quantitative analysis.

The library is fitted with book-shelves and reading table.

The corridor between these last three rooms and the quantitative analysis laboratory is for the purpose of protecting the balance room from the fumes of the laboratory.

THE QUALITATIVE ANALYSIS LABORATORY.

This laboratory has working tables for eighty-four students, allowing a space of 4 feet by 2 feet 6 inches table top for each student. There are two sets of drawers and closets to each space, so that, by dividing the class in two sections, one hundred and sixty-eight students can be accommodated. These desks have gas and vacuum attachments. Each student uses two gas attachments, and there are eight vacuum openings to each table. There are also a drying box for precipitates and a supply of distilled water by two faucets. The fixtures of this room are similar to those of the quantitative analysis laboratory.

At the end of this laboratory is the room for use of sulphureted hydrogen gas. It is provided with shelves on either side, gas attachments, special ventilation and a vestibule to protect the laboratory from the access of gas. The sulphureted hydrogen is made by each student in an ordinary bottle generator. The air space of the qualitative analysis laboratory is 53,200 cubic feet.

The instructors' laboratories have a window looking into their respective laboratories, and are each supplied with all the conveniences for their individual work.

SUPPLY ROOM.

The main supply room is fitted with movable shelves and racks, and contains the stocks of apparatus and chemicals for the various

laboratories, except those for assaying, as well as conveniences for preparing the various solutions of chemicals. Distilled water is supplied by a faucet in this room.

INDUSTRIAL CHEMISTRY ROOM, NO. 1.

The industrial chemistry room No. 1 contains apparatus for testing various technical products in connection with rooms Nos. 2 and 3 of industrial chemistry in the basement, and has tables supplied with the usual laboratory fixtures.

THIRD STORY.

STILL ROOM.

The still for obtaining distilled water is of copper, tin lined, 3 feet high, 2 feet in diameter, with a cap on top $9\frac{1}{2}$ inches high and 1 foot in diameter. The bottom of the cap is perforated and has 2 inches deep of broken porcelain through which the steam passes to the condenser. The top of the cap is covered with copper and a paper washer between clamped to the cap. The water in the still is heated by a copper tin-plated coil, through which the high-pressure steam circulates. The condenser is a block-tin pipe, 1 inch in diameter, coiled within a cylinder of boiler plate 3 feet 2 inches high by 1 foot in diameter. The length of block-tin pipe is about 25 feet. The tank for holding the distilled water is of wood, lined with block tin, 3 feet by 4 feet by 2 feet high, capacity 6 barrels. The movable cover is also lined with block tin, and is flanged so as to thoroughly protect the water from dust contamination. The tank can be filled in 10 hours.

The distilled water is conducted to the rooms to which it is supplied by block-tin pipes. The faucets have self-closing cocks, and are silver plated in all their parts to prevent contamination.

In the upper part of the still room is an iron tank of 80 barrels capacity, into which the water from the town supply flows and from which all water attachments in the building are supplied, thus securing a regular pressure at the outlets.

PHOTOGRAPHY ROOMS.

The main room has a north light, and is supplied with the usual conveniences. The dark rooms have sheet-lead floors, turned up at the sides to protect the ceilings below; a wooden slatted floor protects the lead floor. In each dark room are two wooden flushing sinks for washing prints, and a white crockery sink for ordinary purposes.

Here also is given instruction in the use of the microscope and the spectroscope.

The various laboratories are supplied with all the necessary ap-

paratus. The students make a deposit to cover the expense of apparatus and chemicals, and obtain these upon their own written order upon applying at the delivery window of the supply room between 2 and 4 o'clock p. m.

On each floor of the building are water attachments with hose for fire purposes, together with chemical fire extinguishers. Outside the building are three fire plugs for the same purpose, with fire hose close at hand.

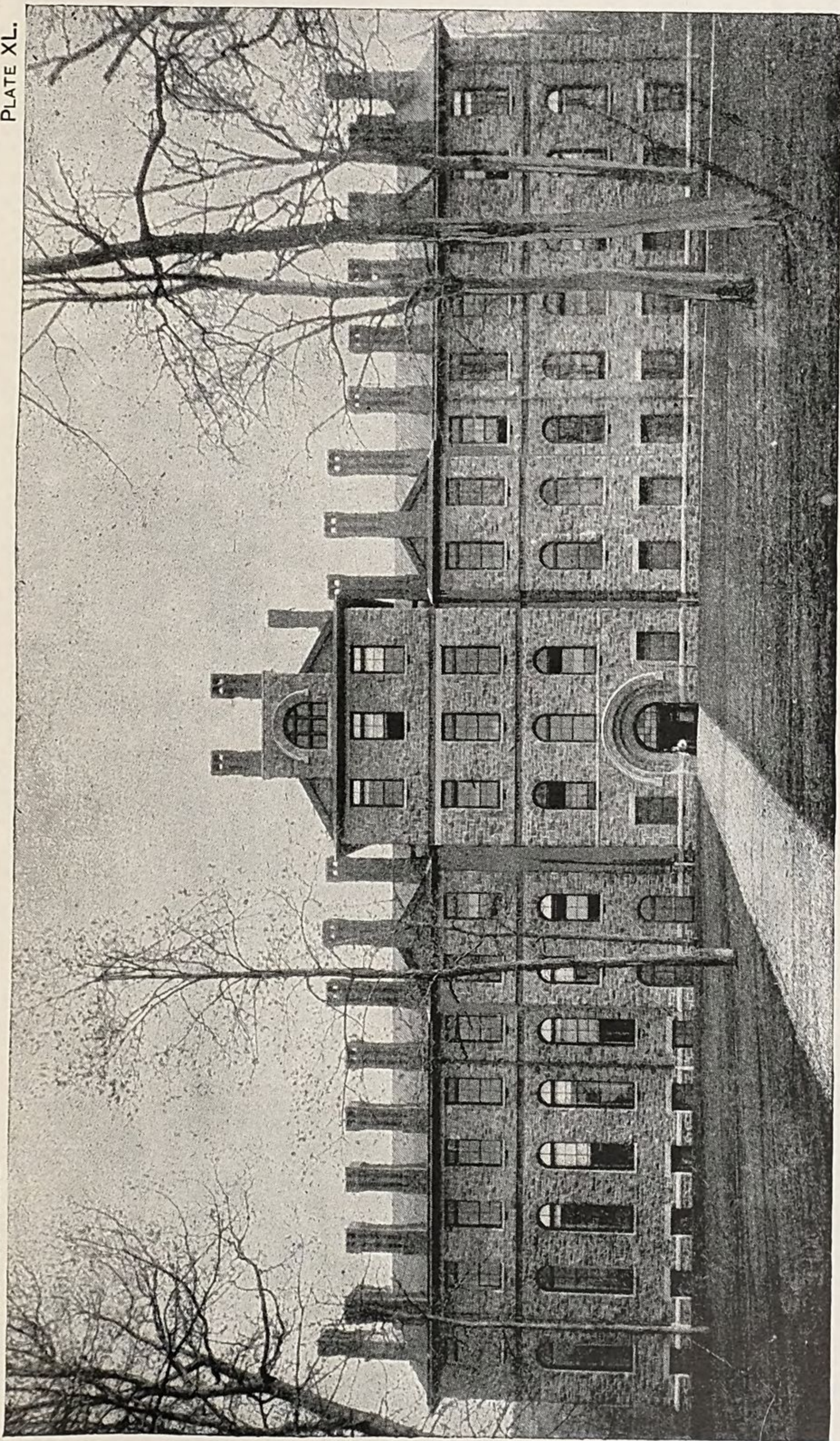
DEPARTMENT OF MINERALOGY AND METALLURGY.

On the first story are the wet and dry laboratories for the use of this department. The former is fitted similar to the laboratory for quantitative analysis, the latter is supplied with various air-blast and gas furnaces for metallurgical experiments.

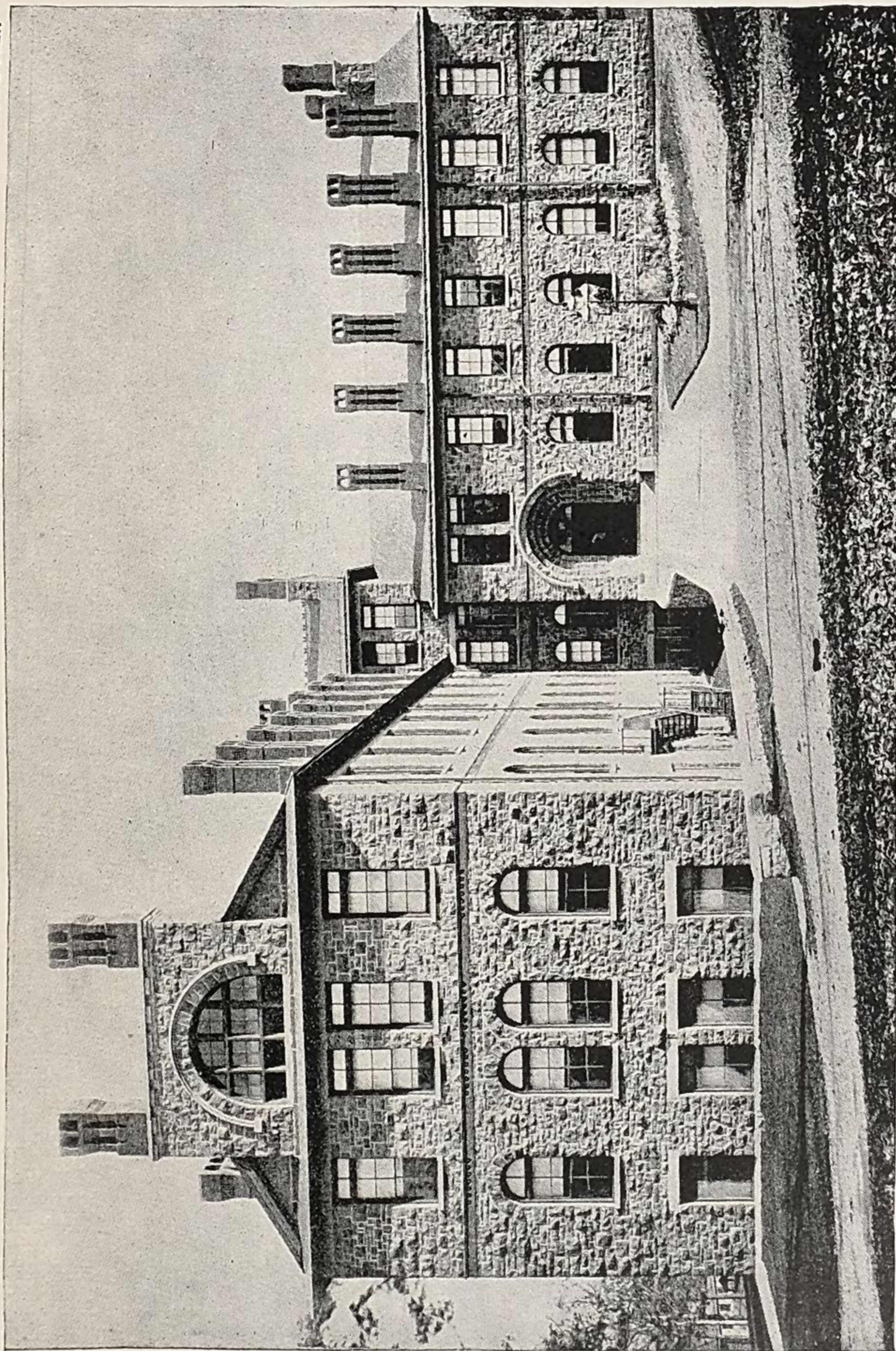
The blowpipe laboratory is supplied with working tables for instruction in blowpipe analysis, crystallography, and mineralogy. The specimens for examination are preserved in a series of shallow drawers.

The packing room contains machines for preparing mineral sections, and the instrument room contains apparatus for the examination of minerals.

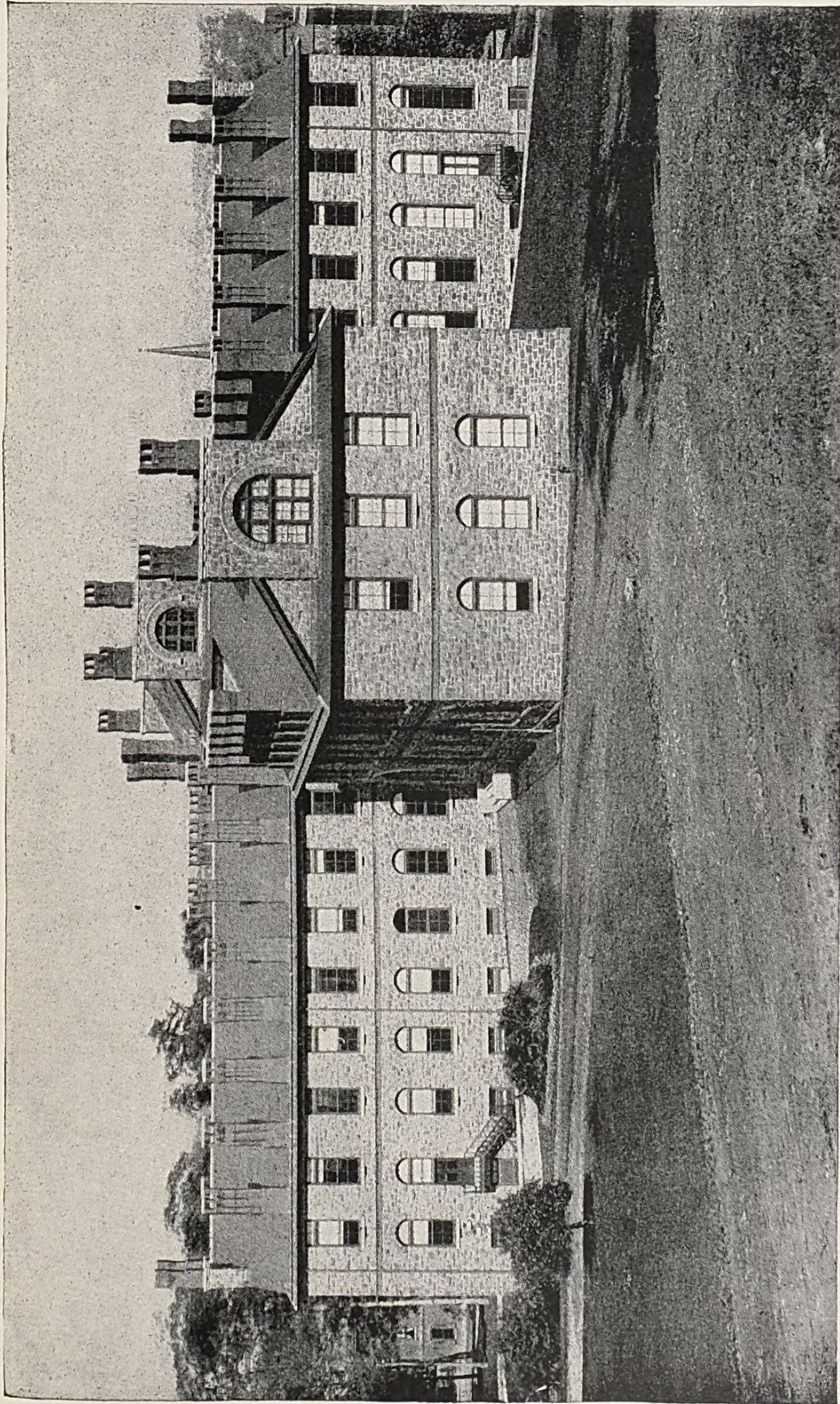
On the second story is the lecture room for the department, the museum of mineralogy and metallurgy, the mineralogical laboratory, and the professor's study.



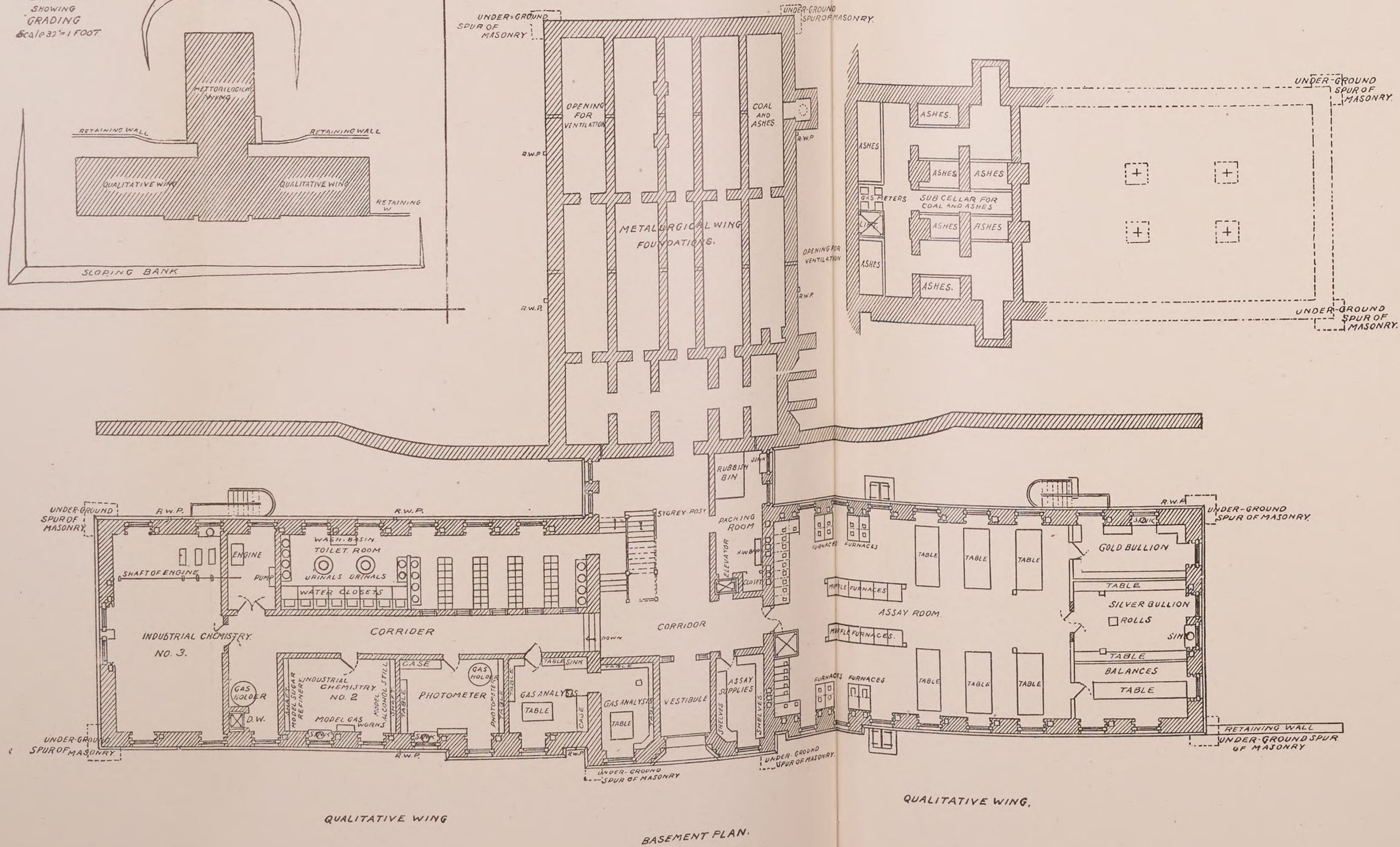
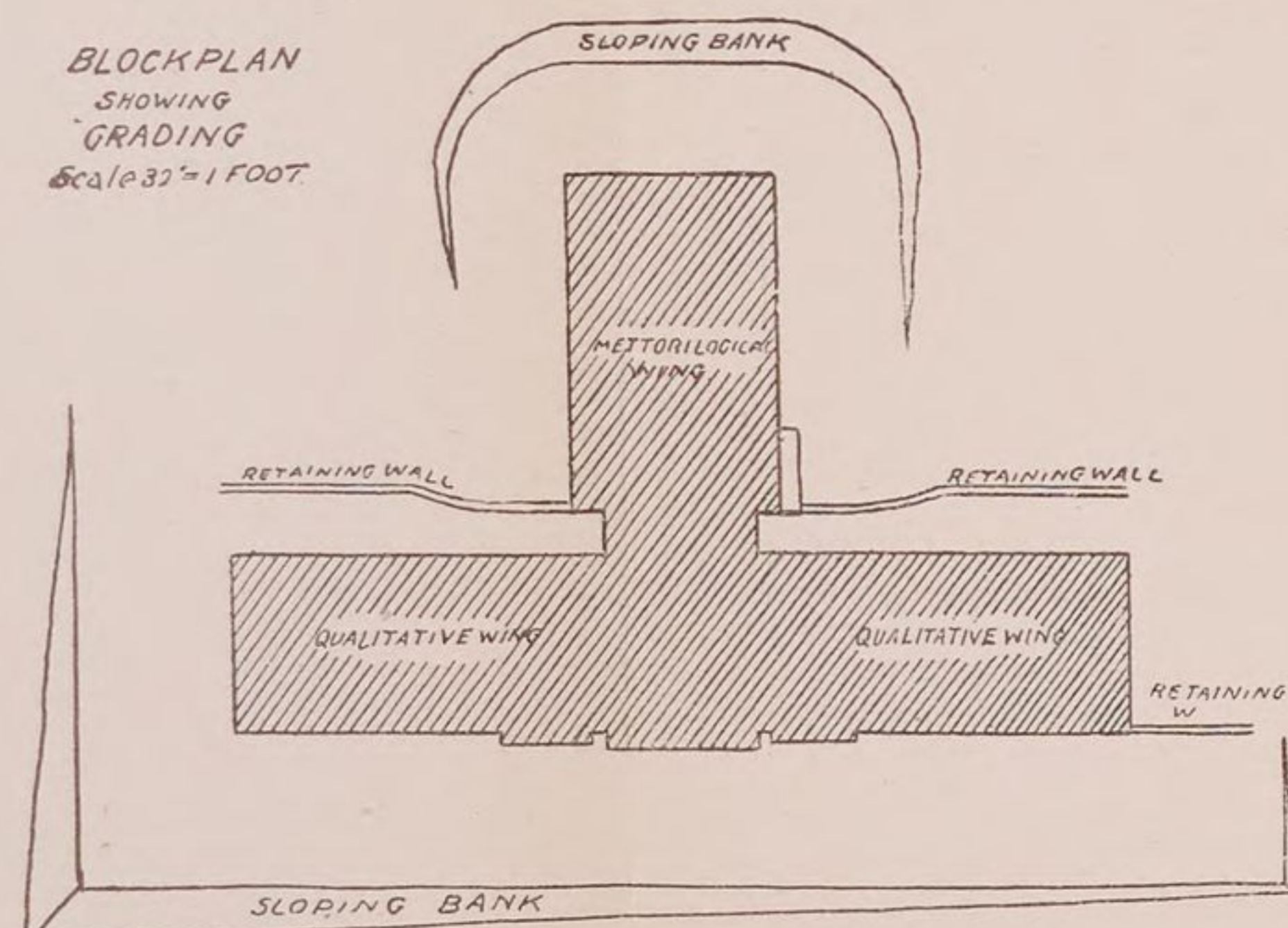
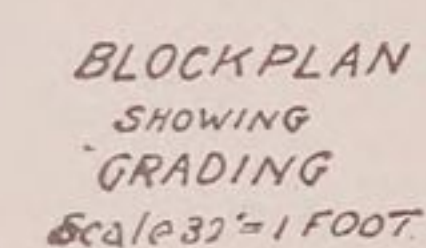
THE CHEMICAL LABORATORY OF THE LEHIGH UNIVERSITY, SOUTH BETHLEHEM, PENNSYLVANIA—FRONT VIEW.



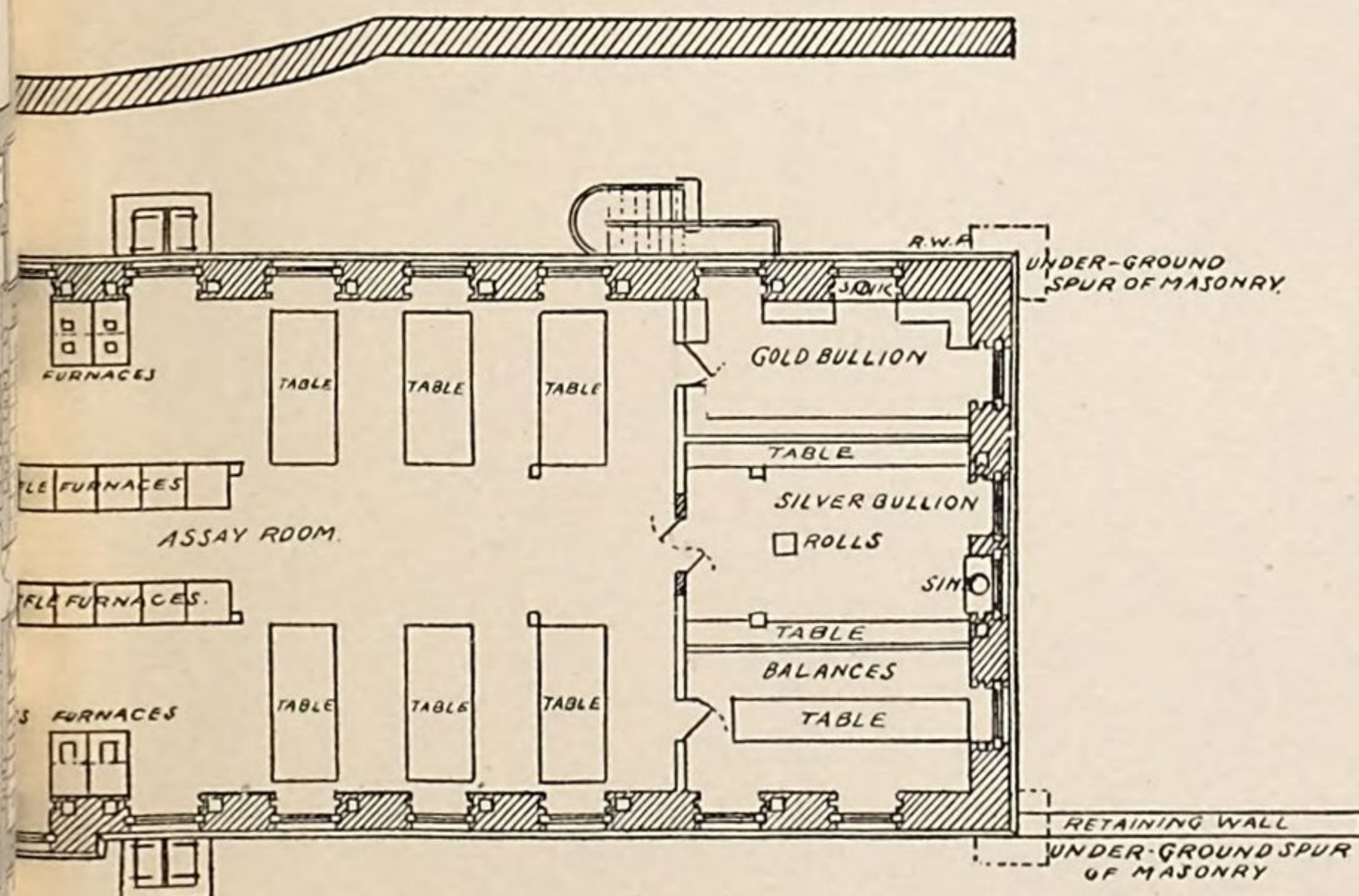
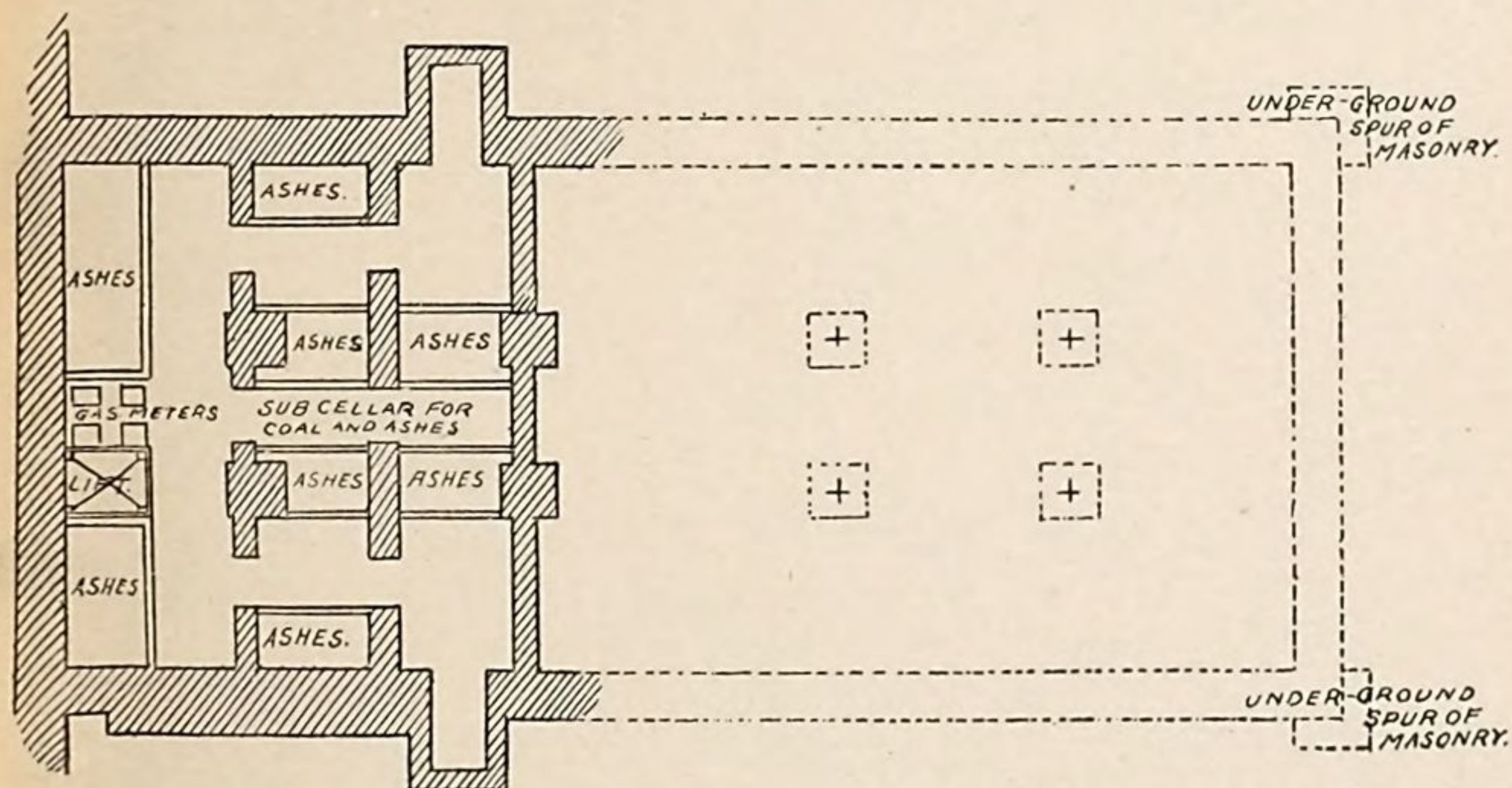
LEHIGH LABORATORY—END VIEW.



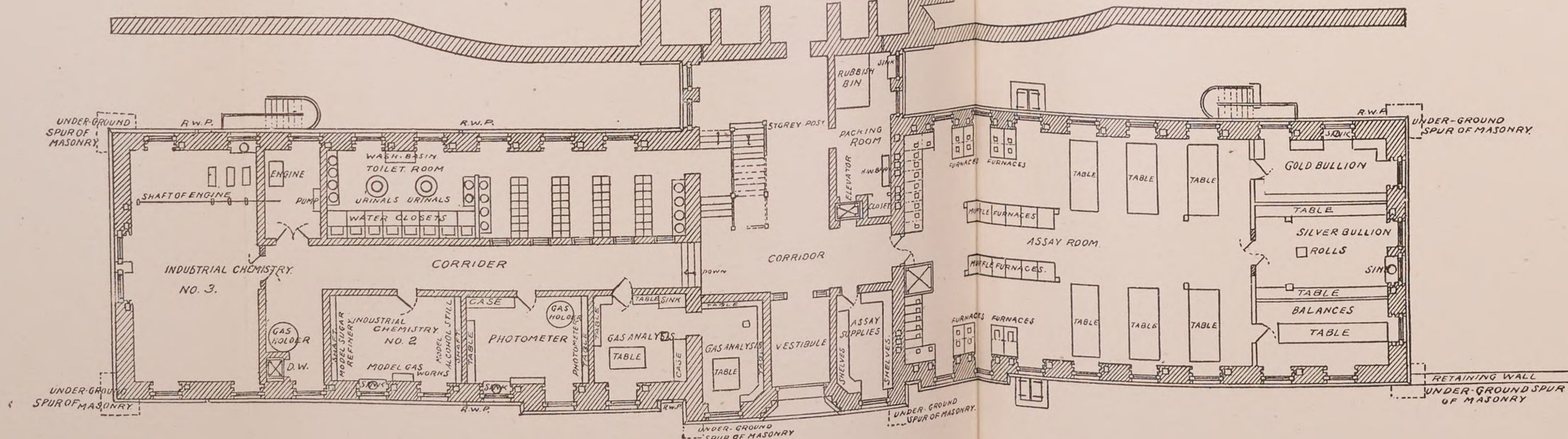
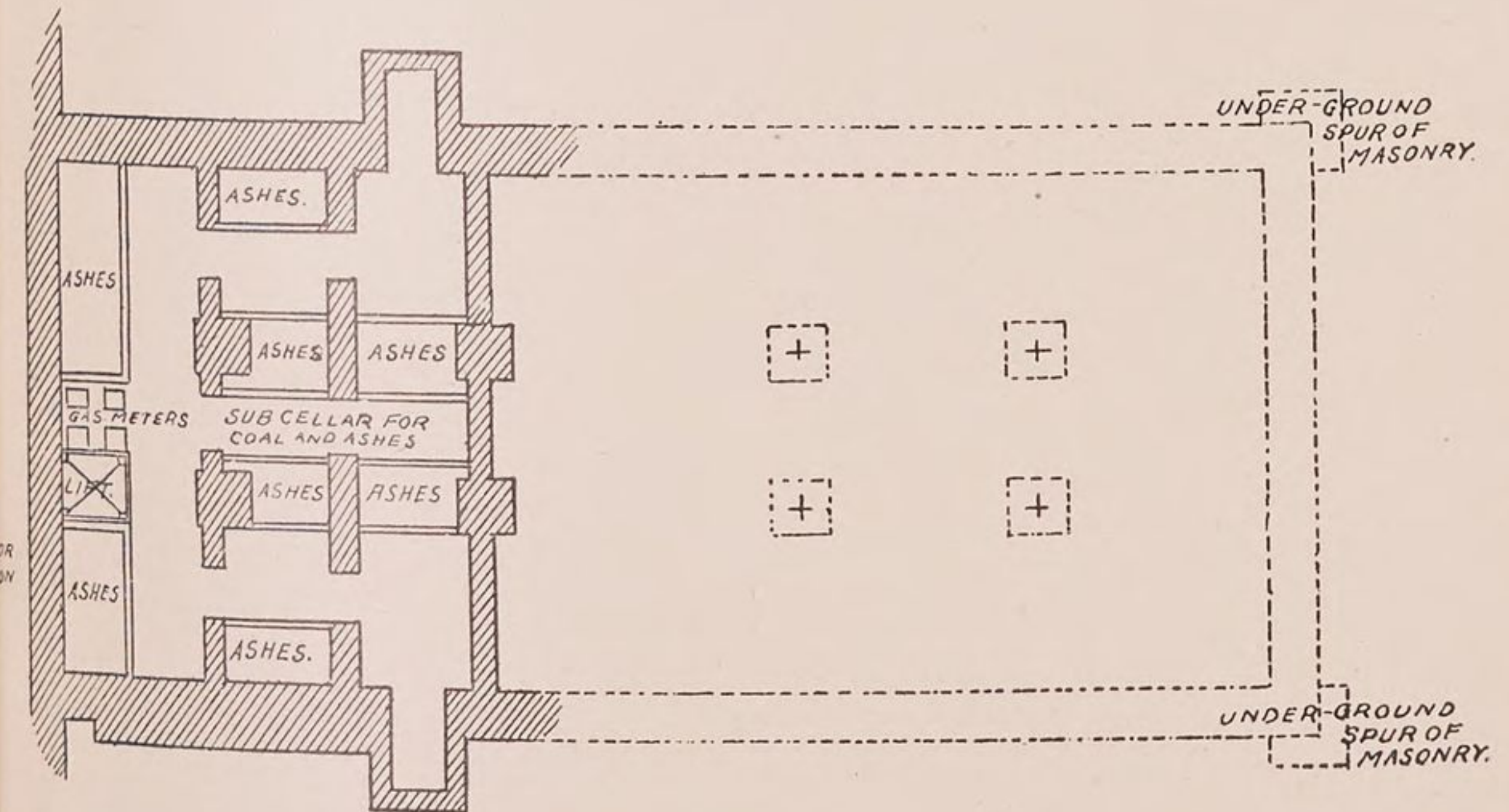
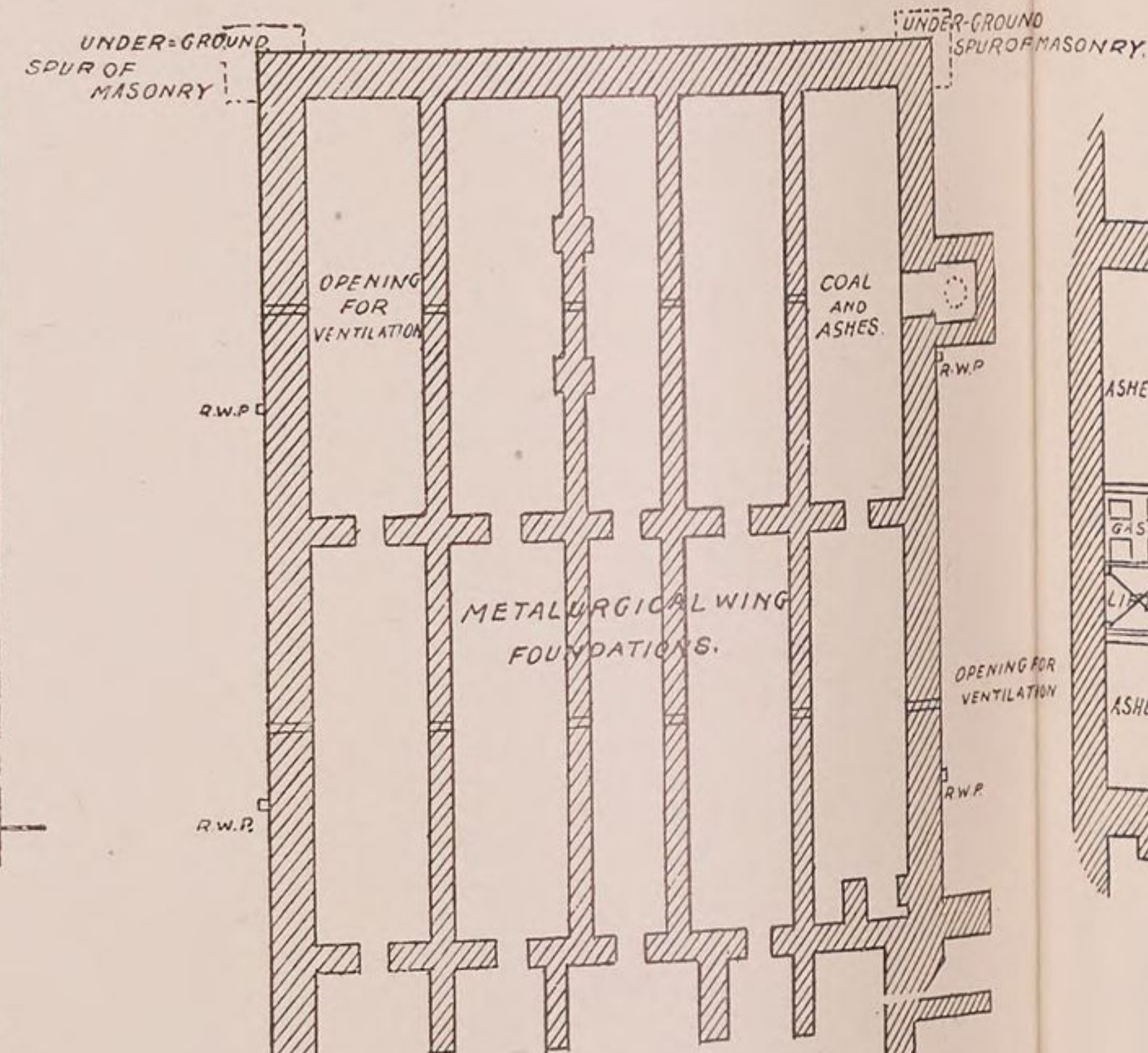
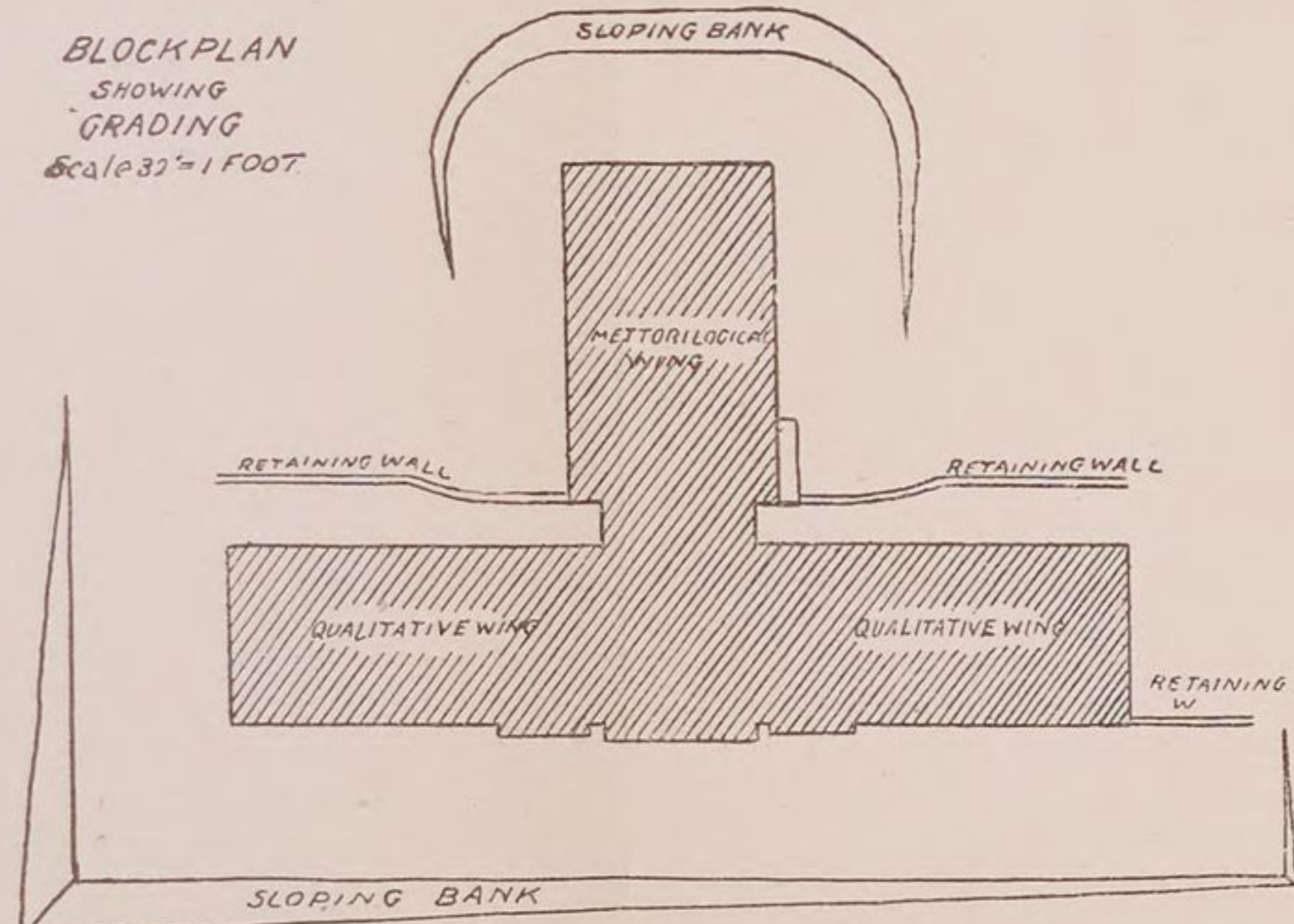
LEHIGH LABORATORY—REAR VIEW.



MASONRY.



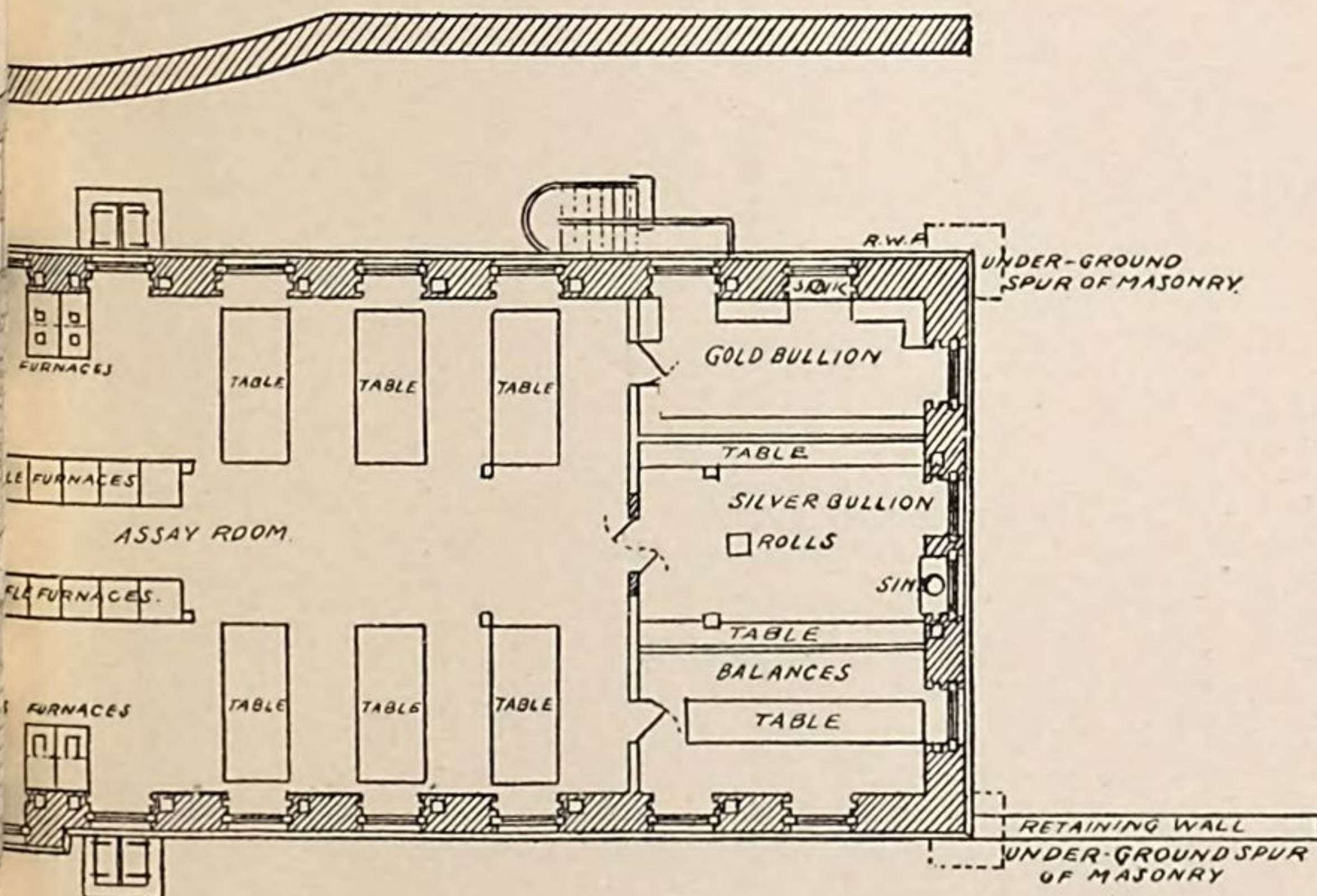
BLOCK PLAN
SHOWING
GRADING
Scale 1/32" = 1 FOOT.



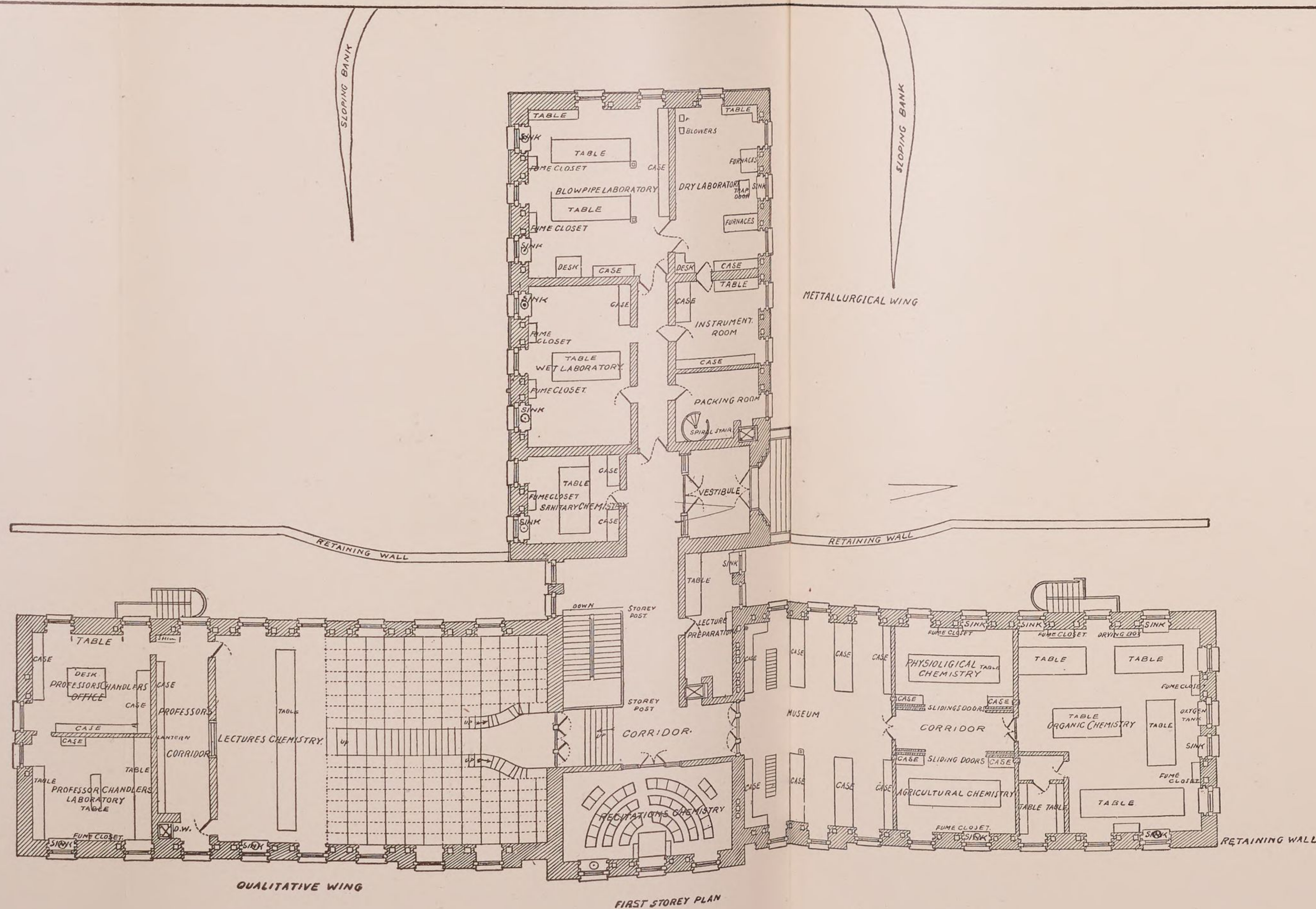
QUALITATIVE WING

BASEMENT PLAN.

QUALITATIVE WING.



QUALITATIVE WING.

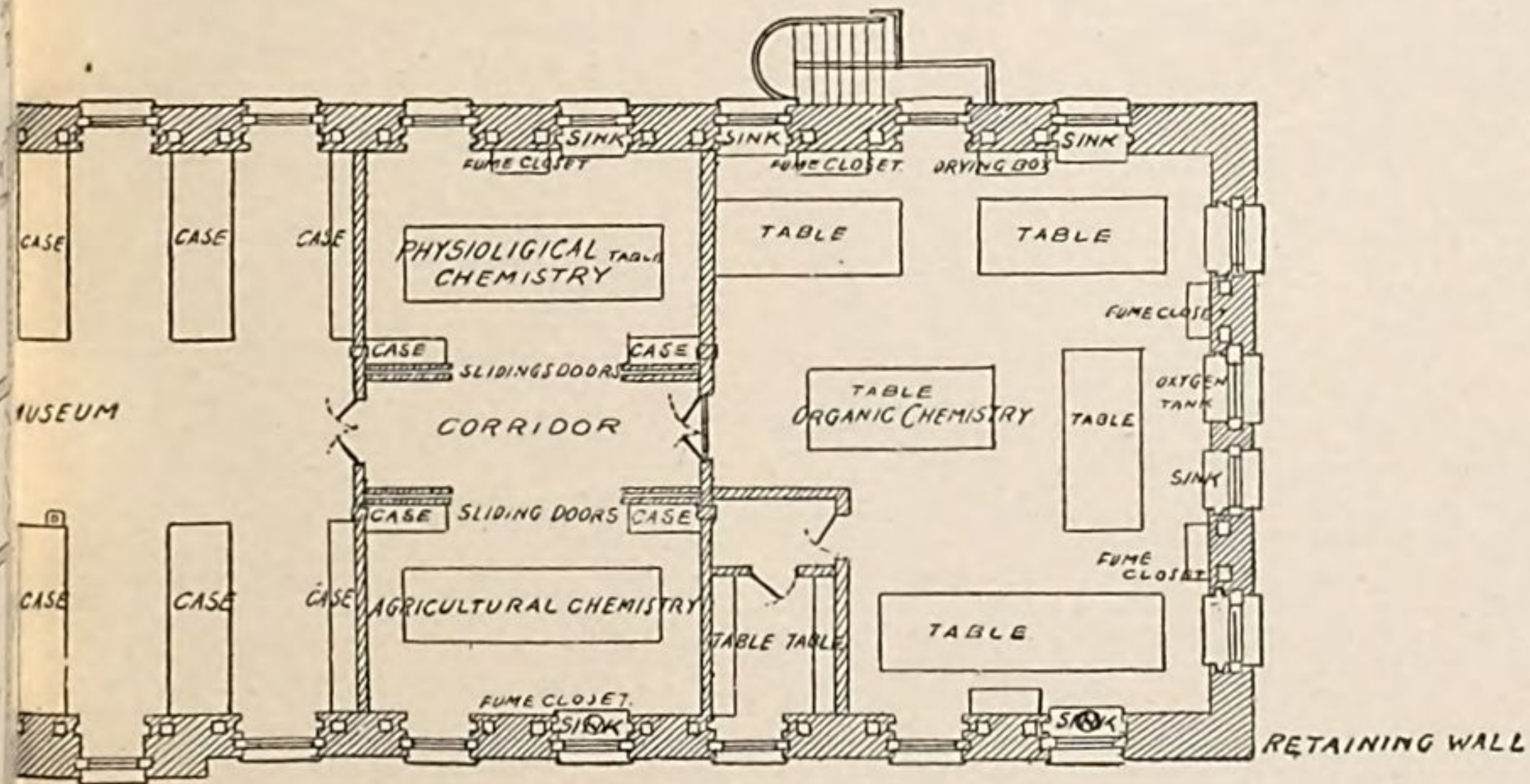


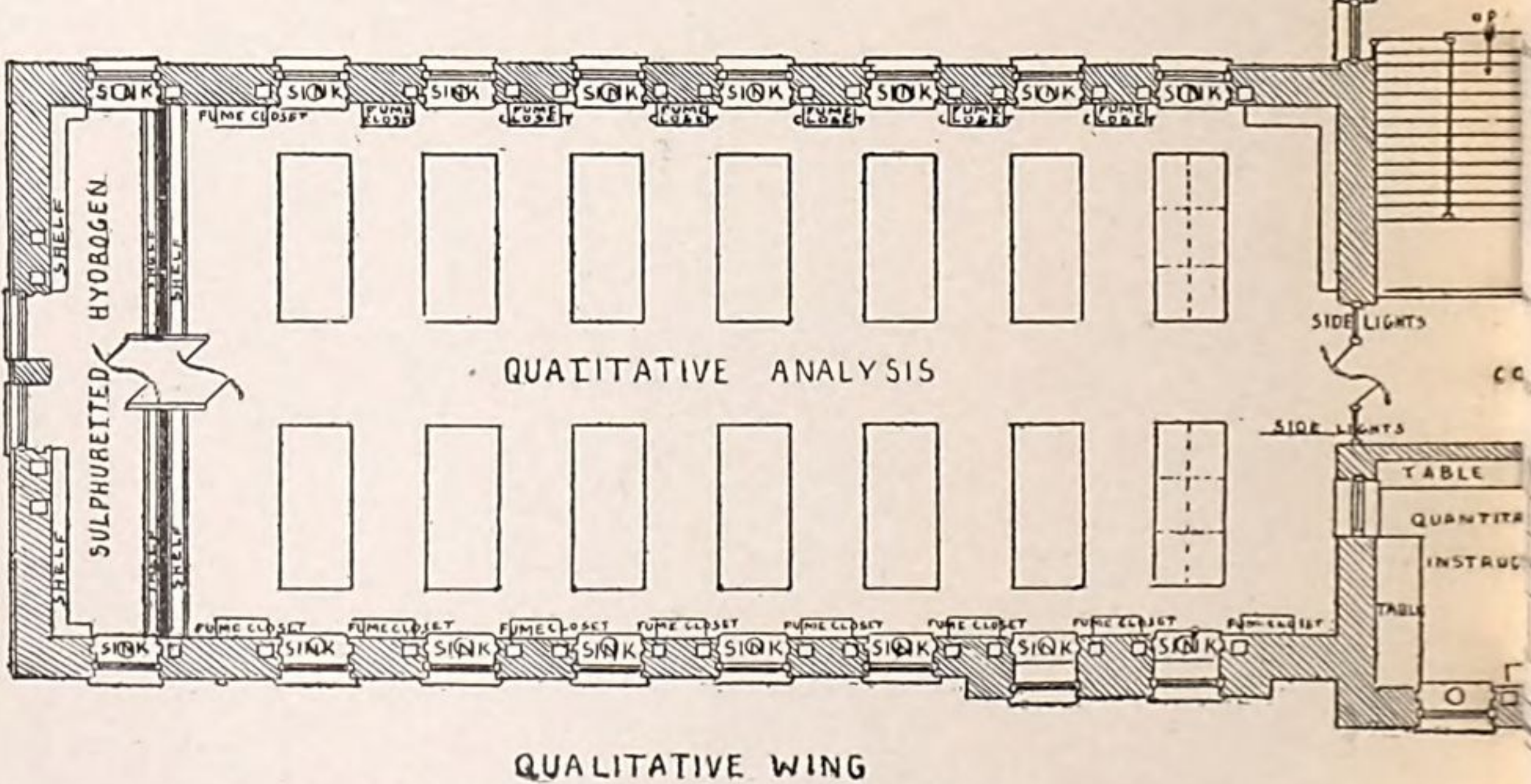
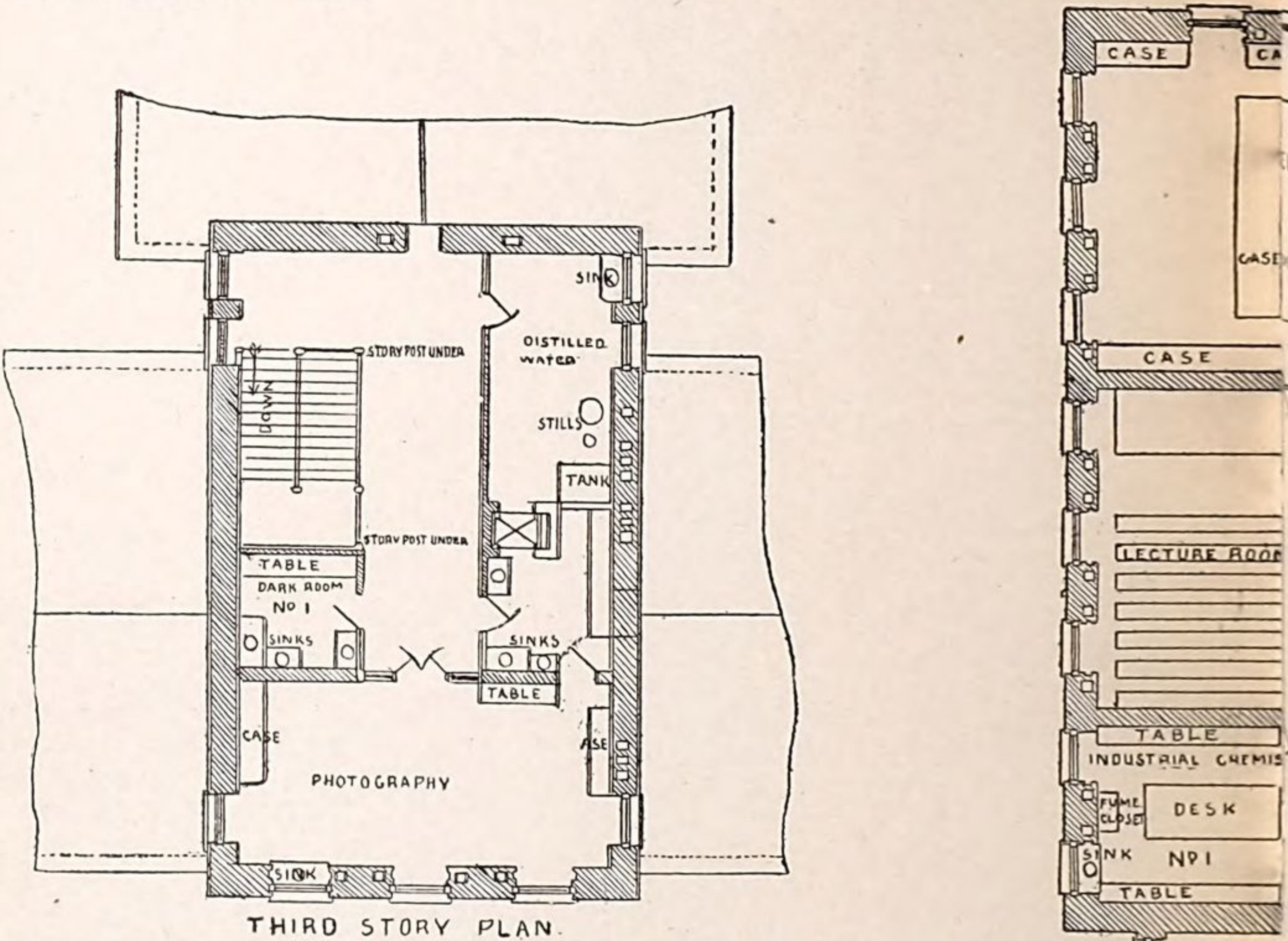
LEHIGH LABORATORY.

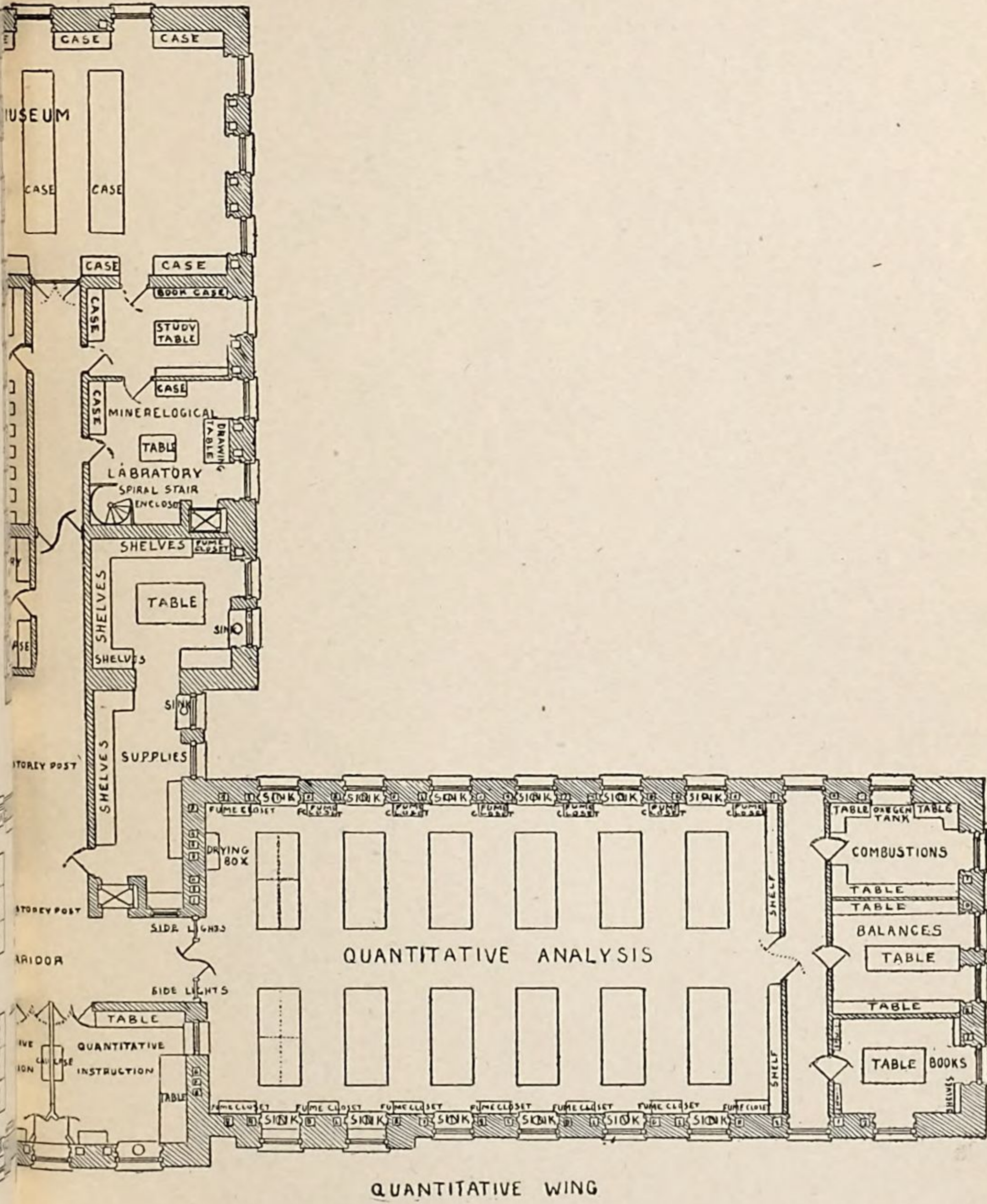
SLOPING BANK

METALLURGICAL WING

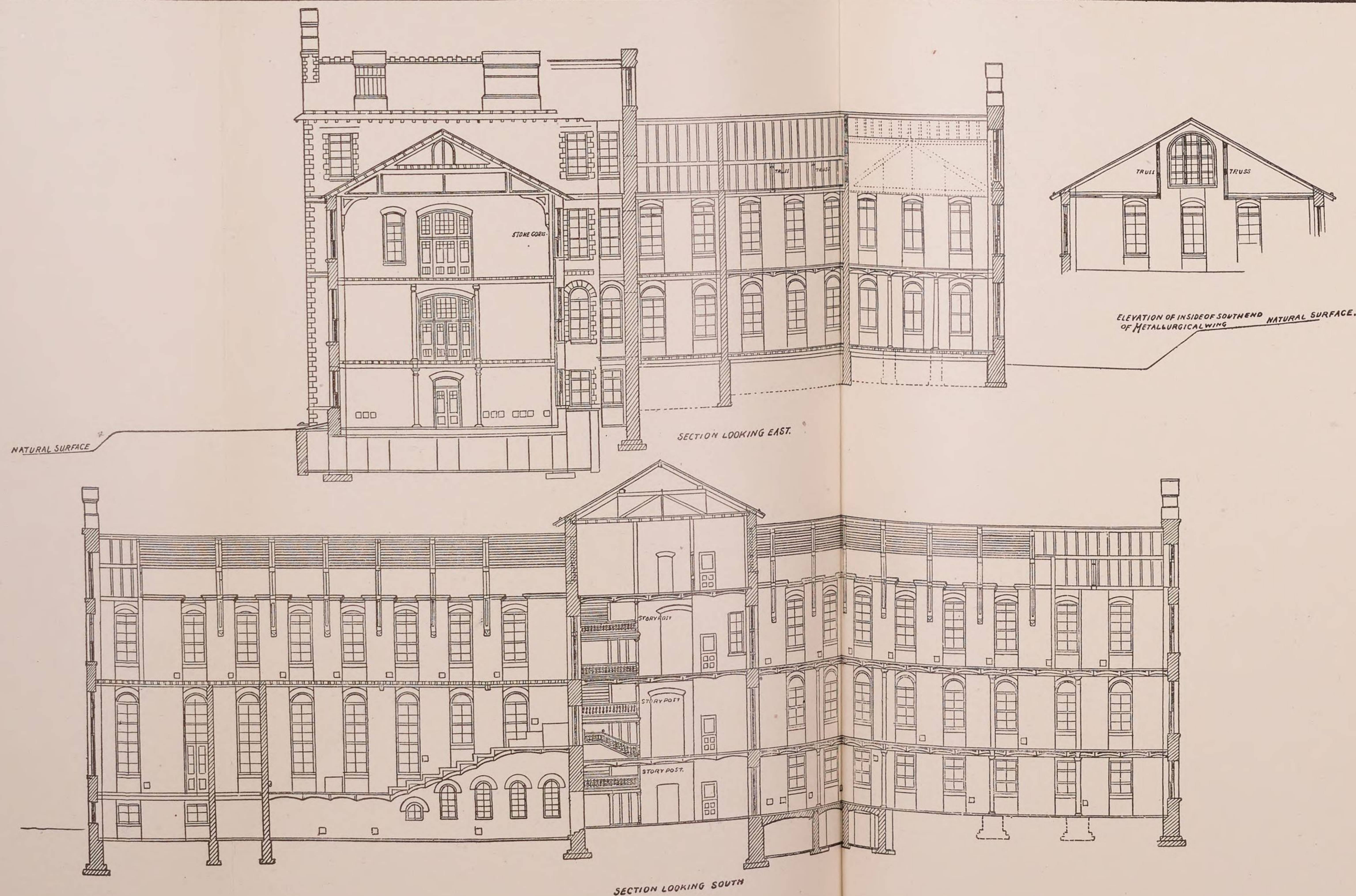
RETAINING WALL

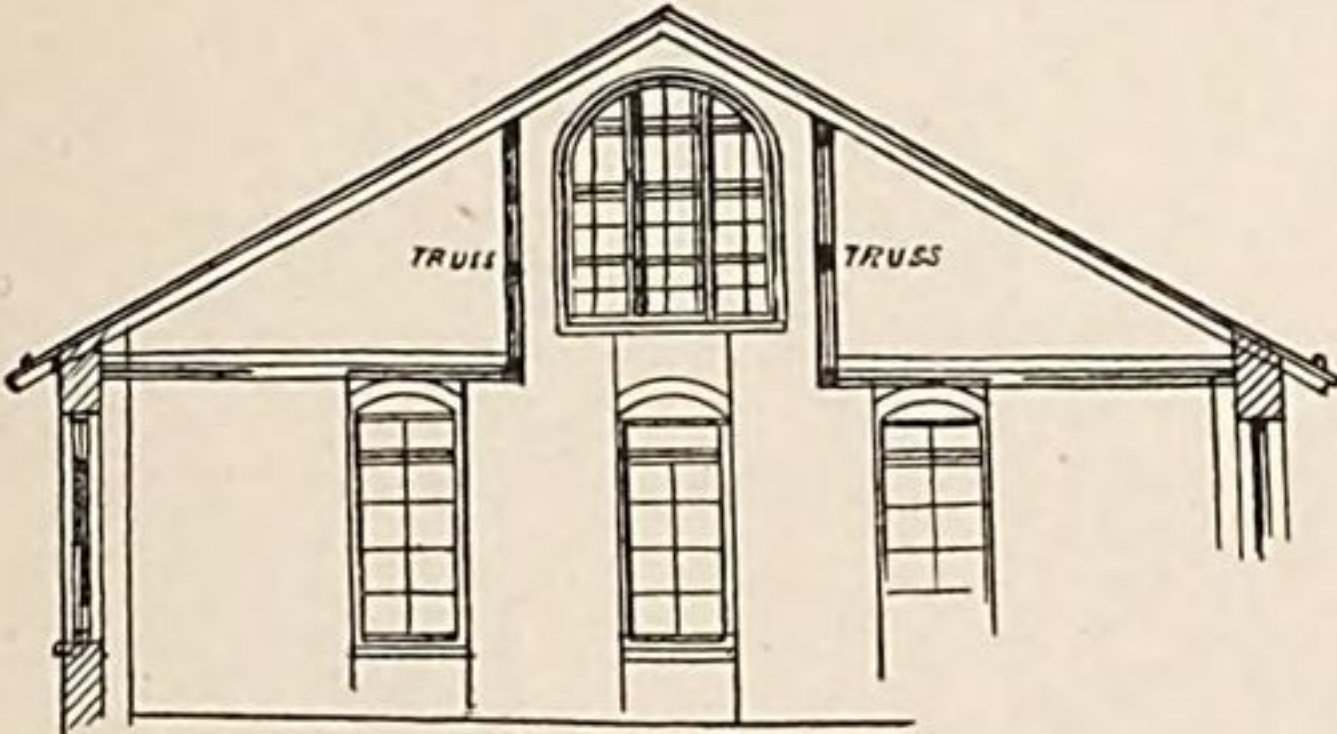
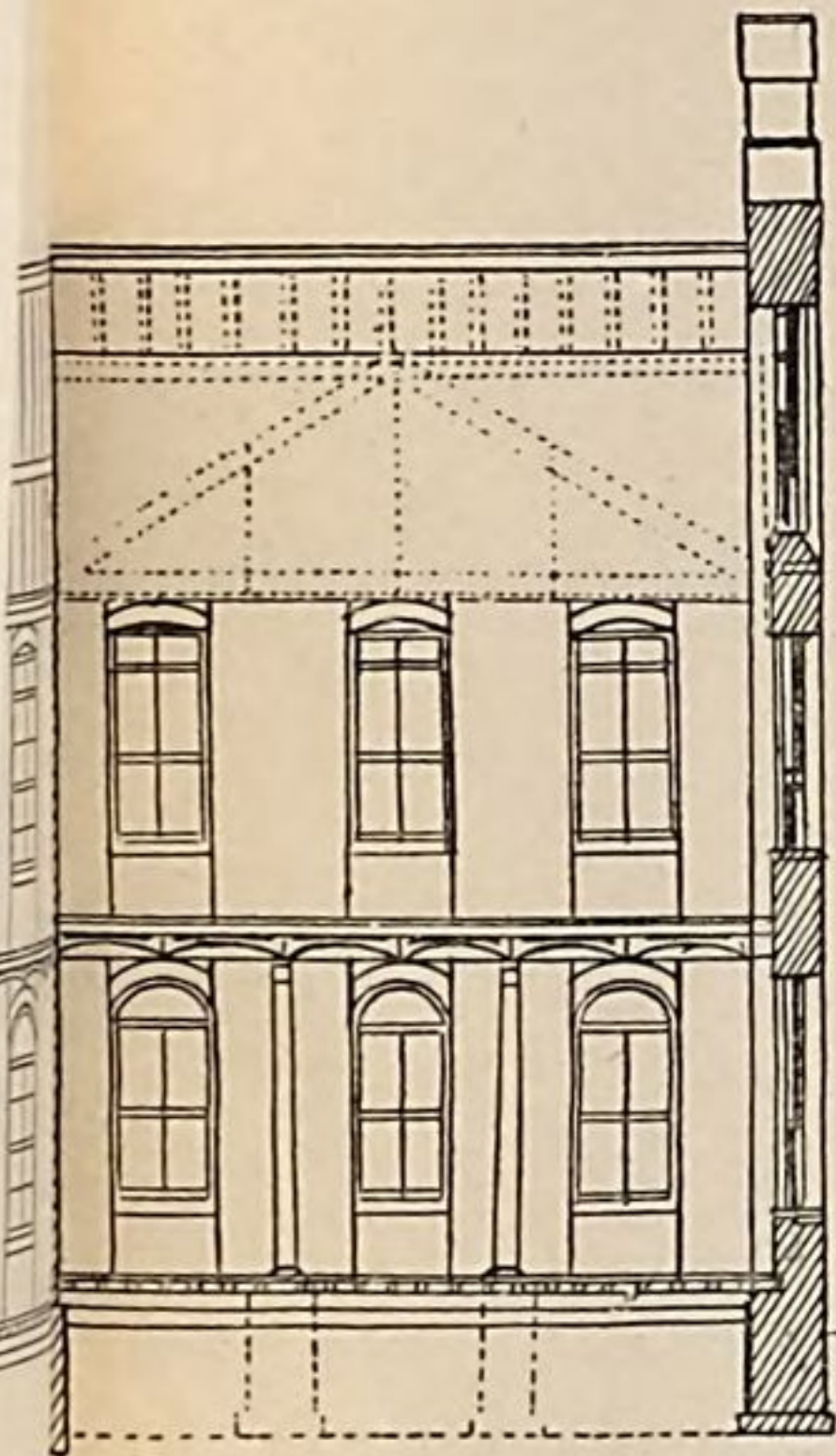




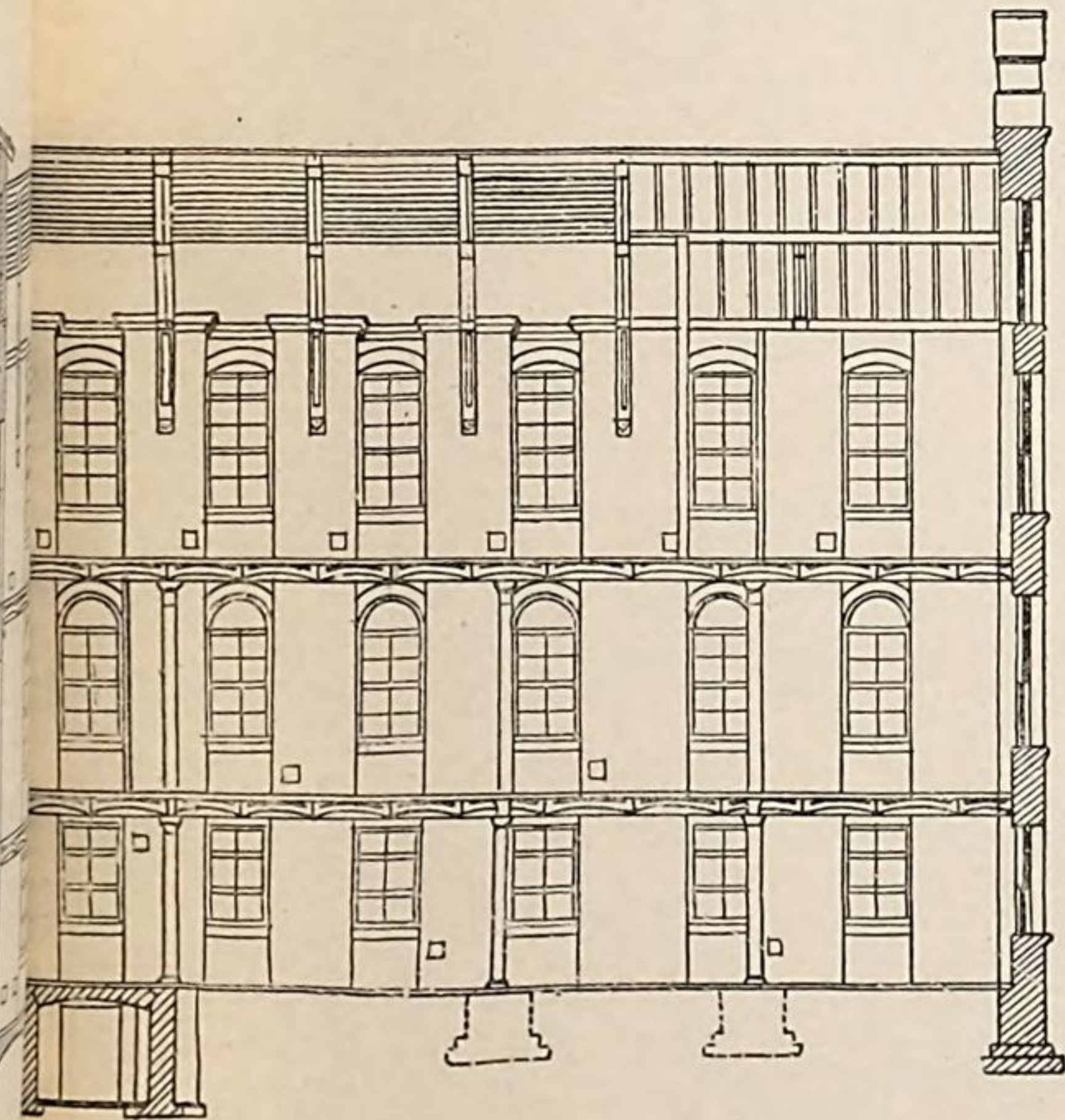


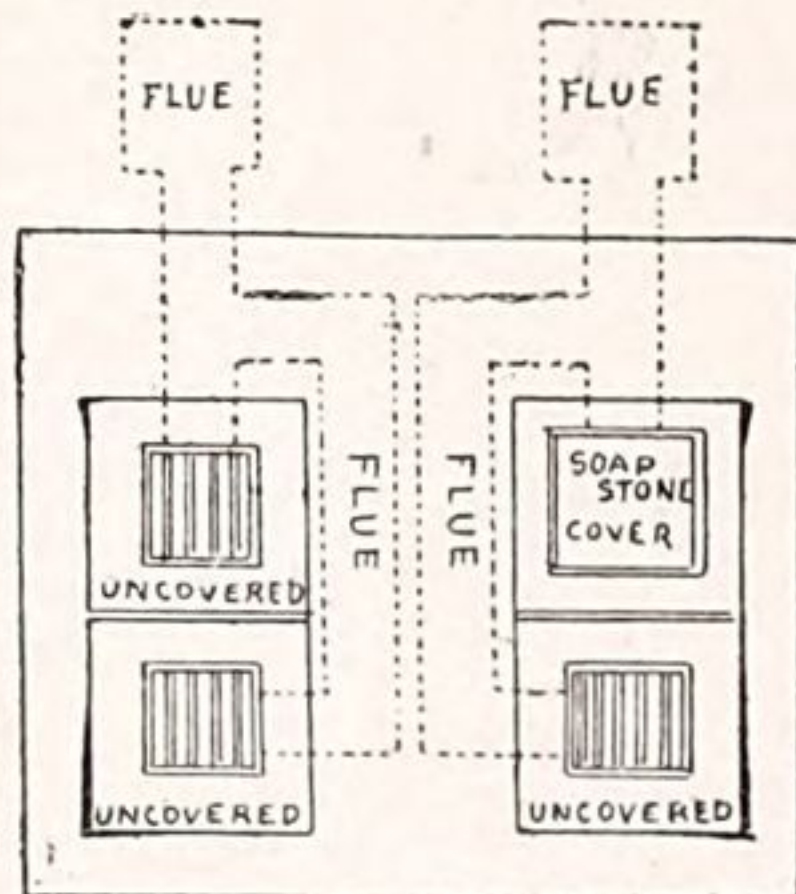
STORY PLAN
LABORATORY.



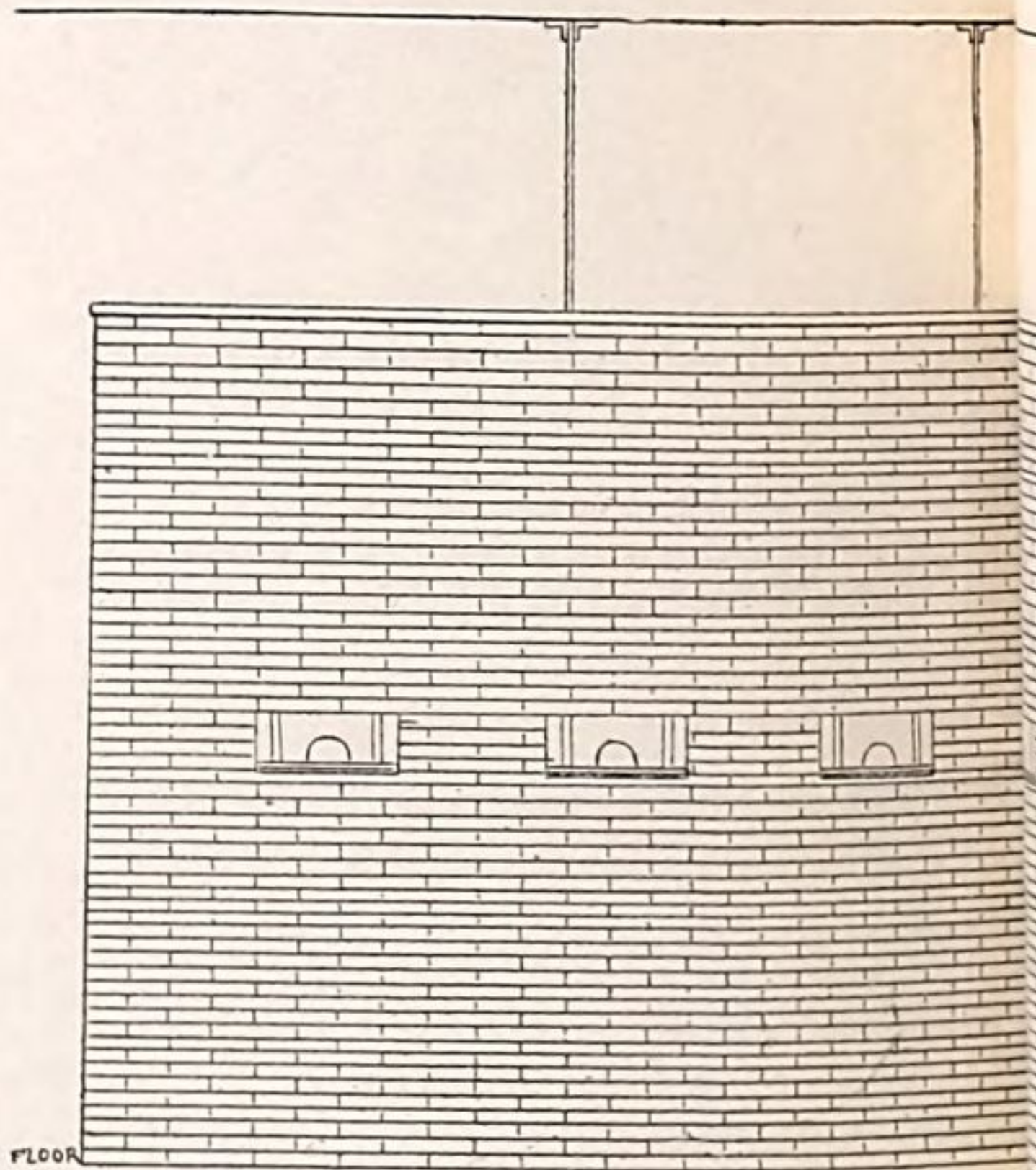
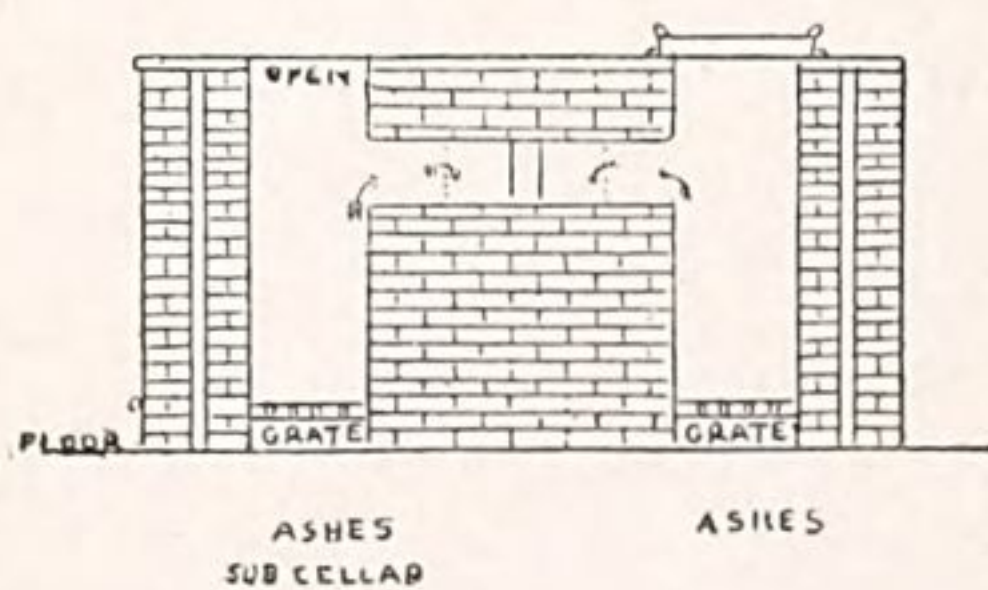


ELEVATION OF INSIDE OF SOUTH END NATURAL SURFACE.
OF METALLURGICAL WING

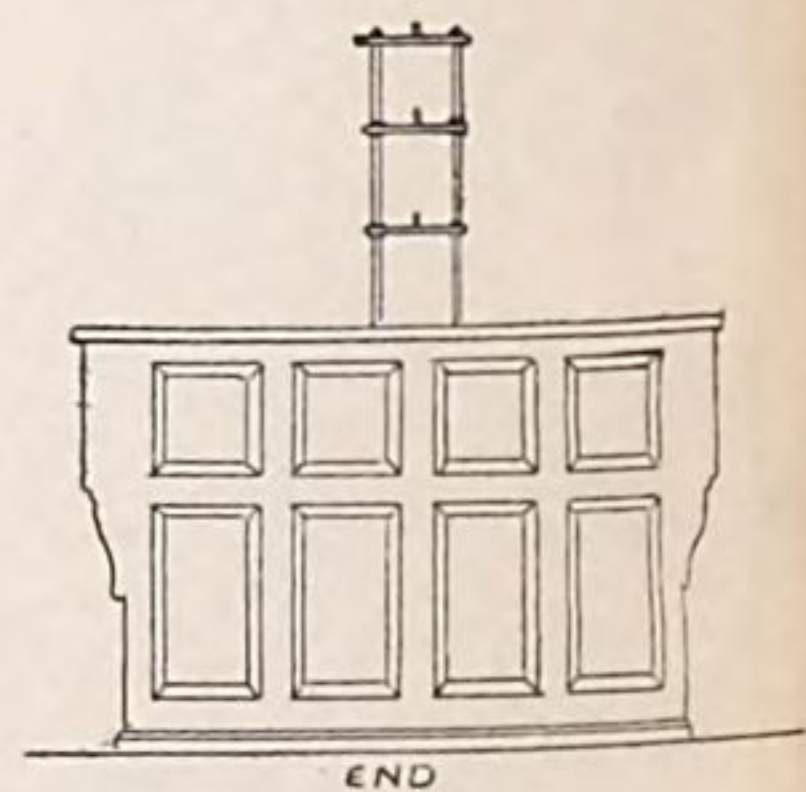
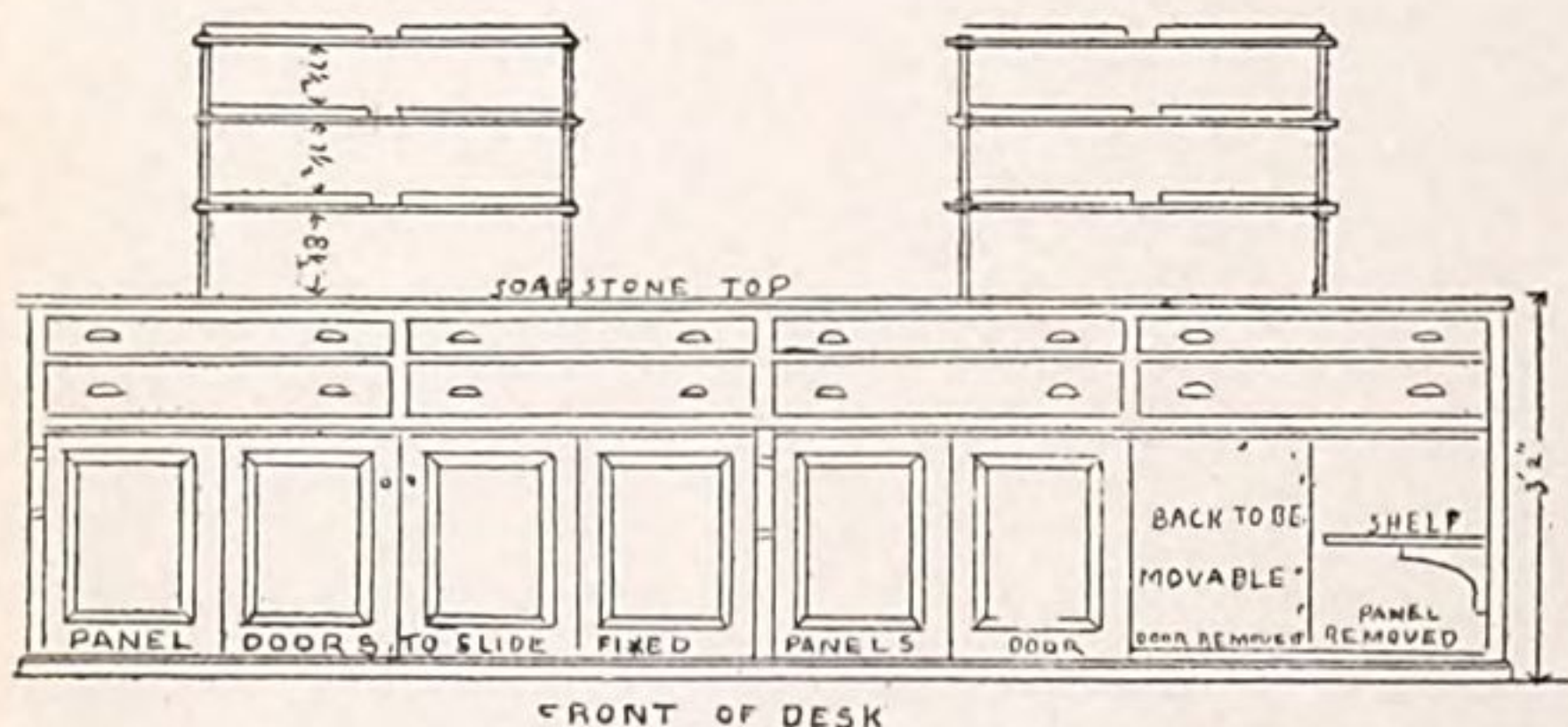




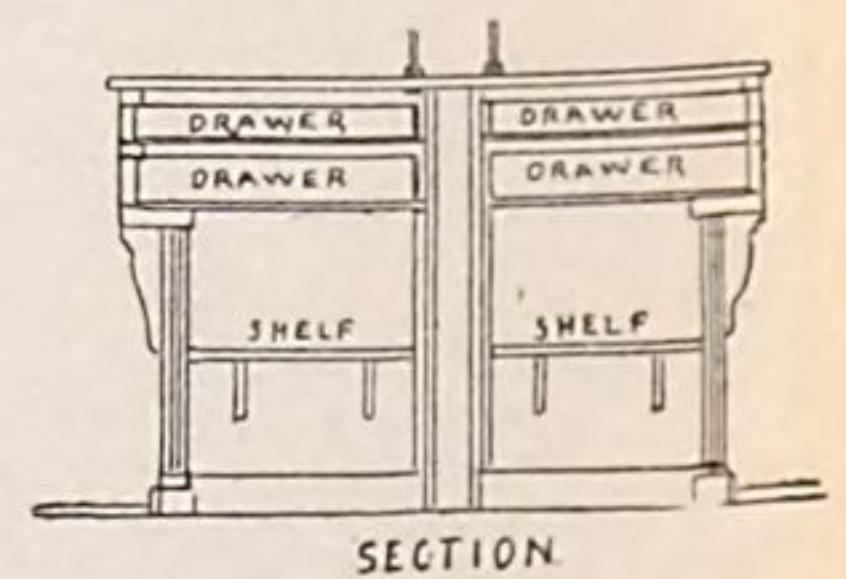
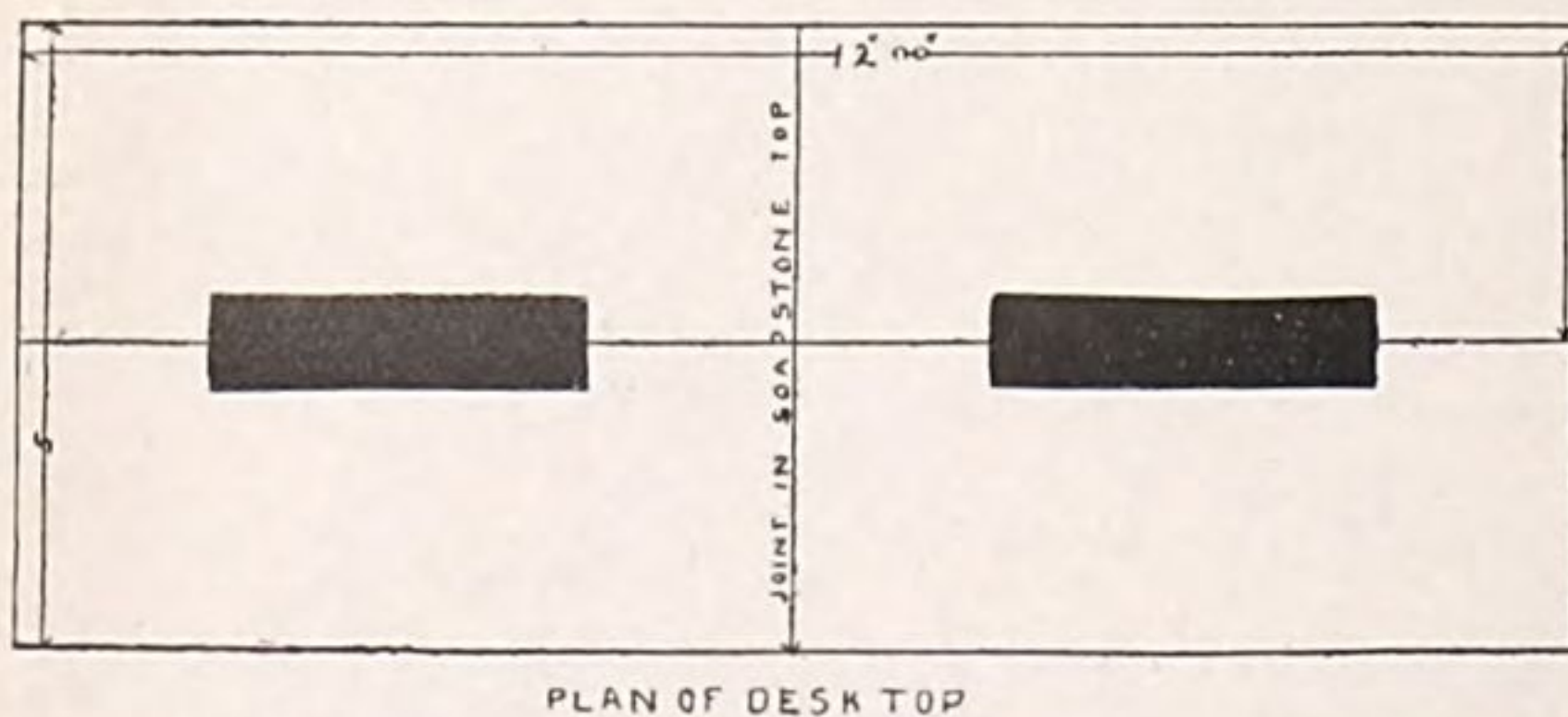
CRUCIBLE FURNACE

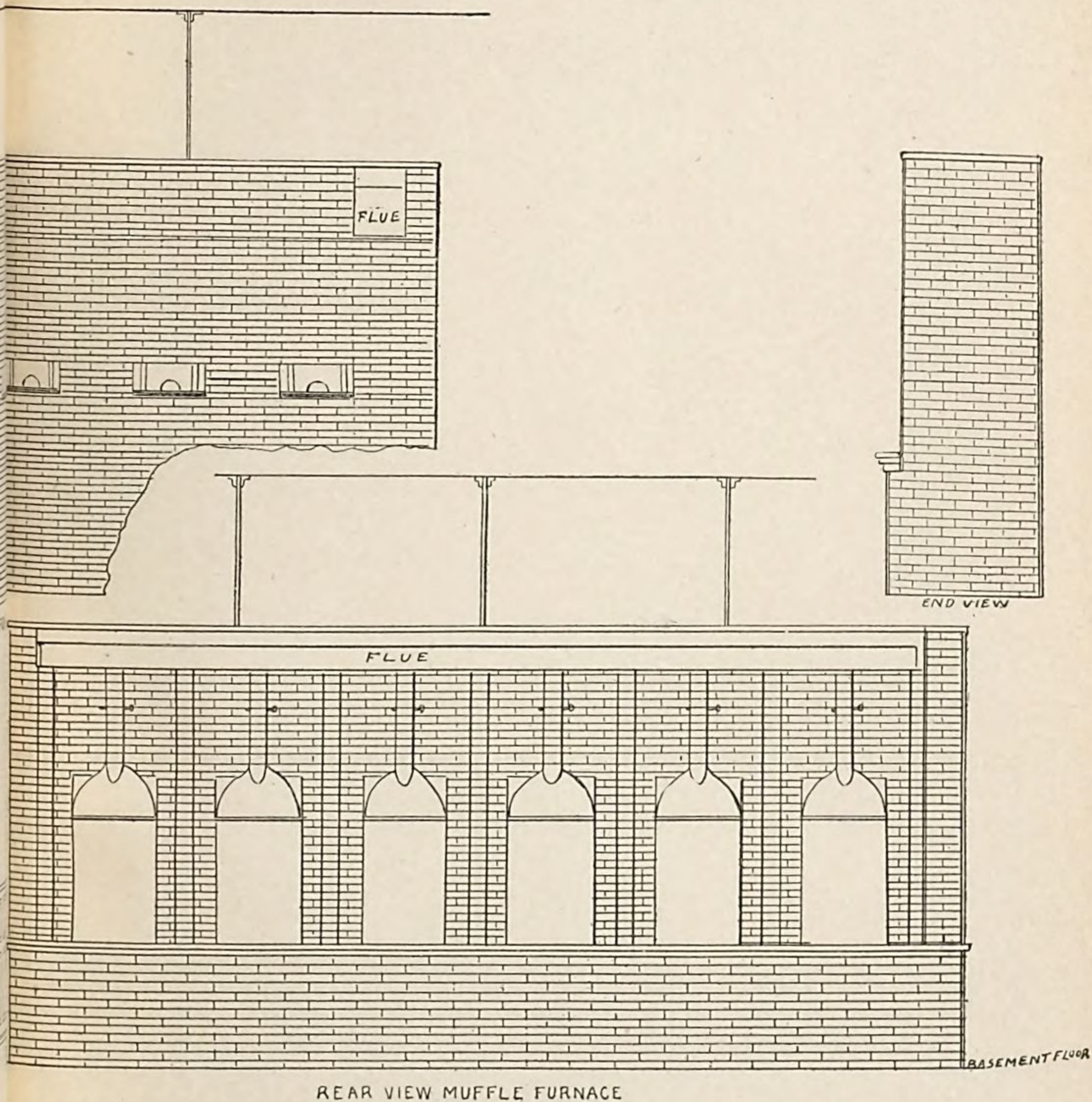


MUFFLE FURNACE FRONT VIEW

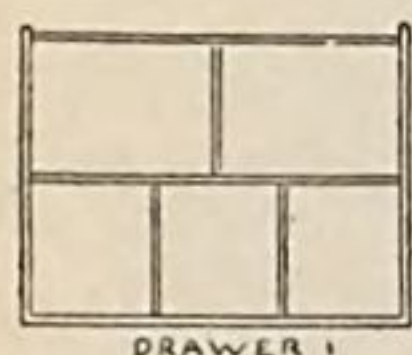


QUANTITATIVE DESK

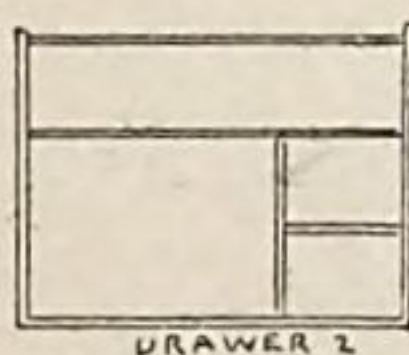




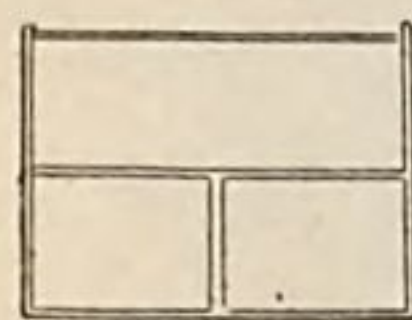
REAR VIEW MUFFLE FURNACE



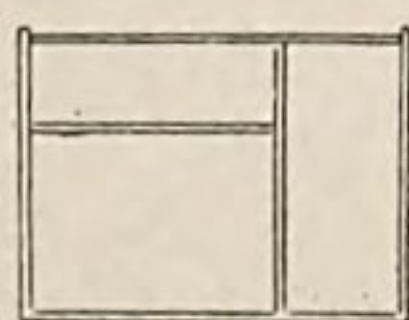
DRAWER 1



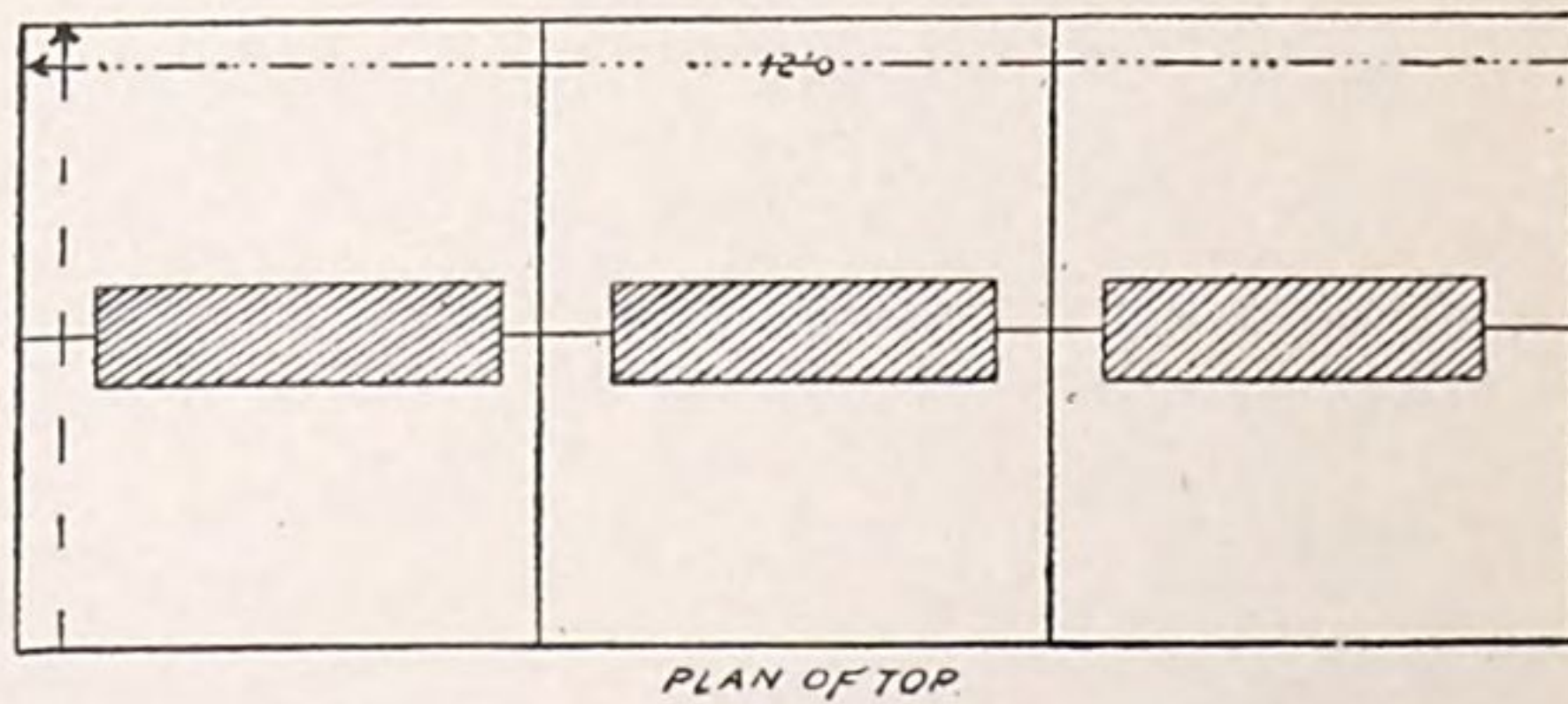
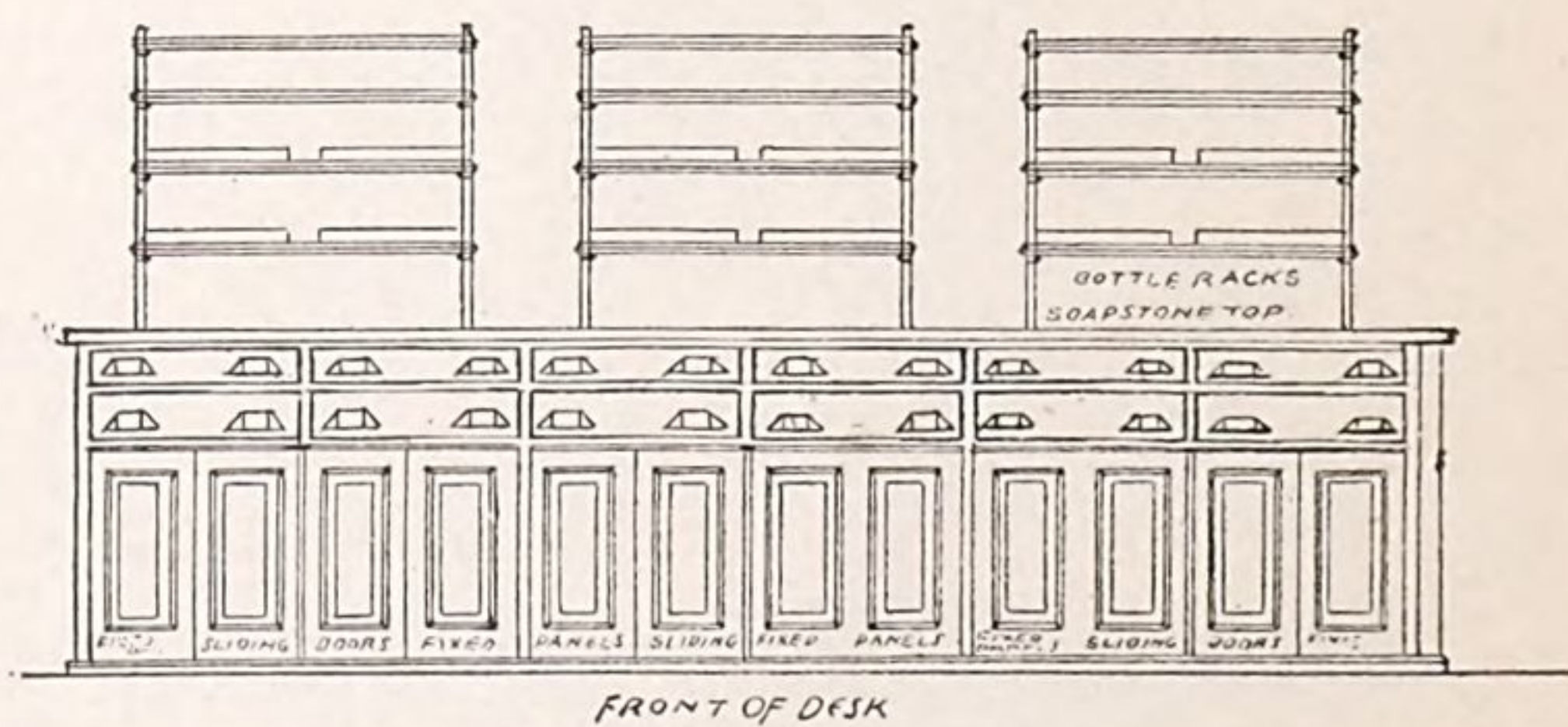
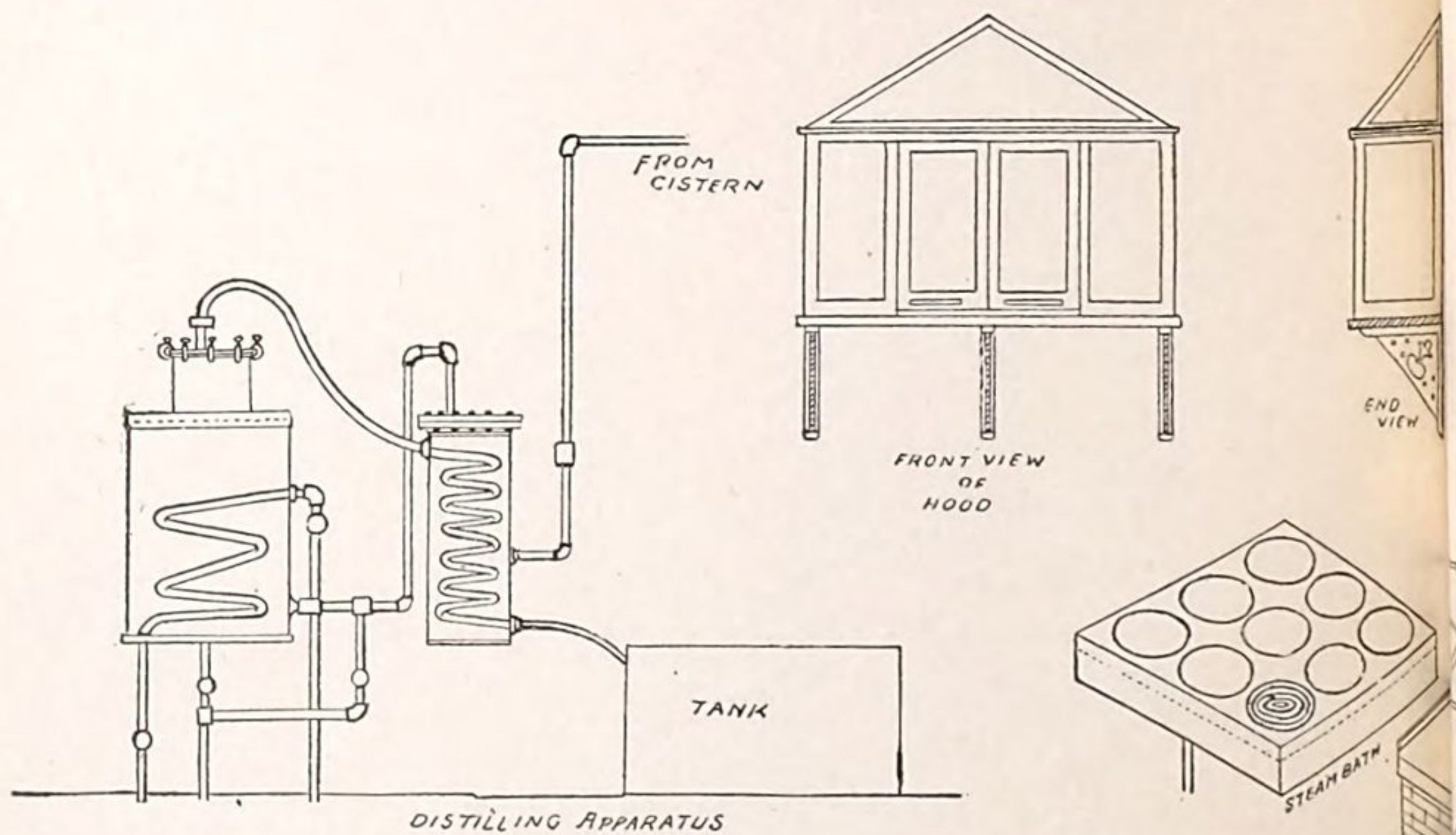
DRAWER 2



DRAWER 3



DRAWER 4



SOAPSTONE TOP

DRAWER
FRONT

BOTTOM

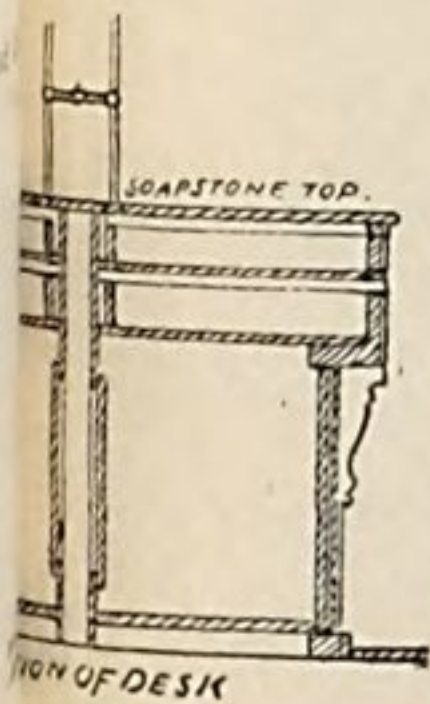
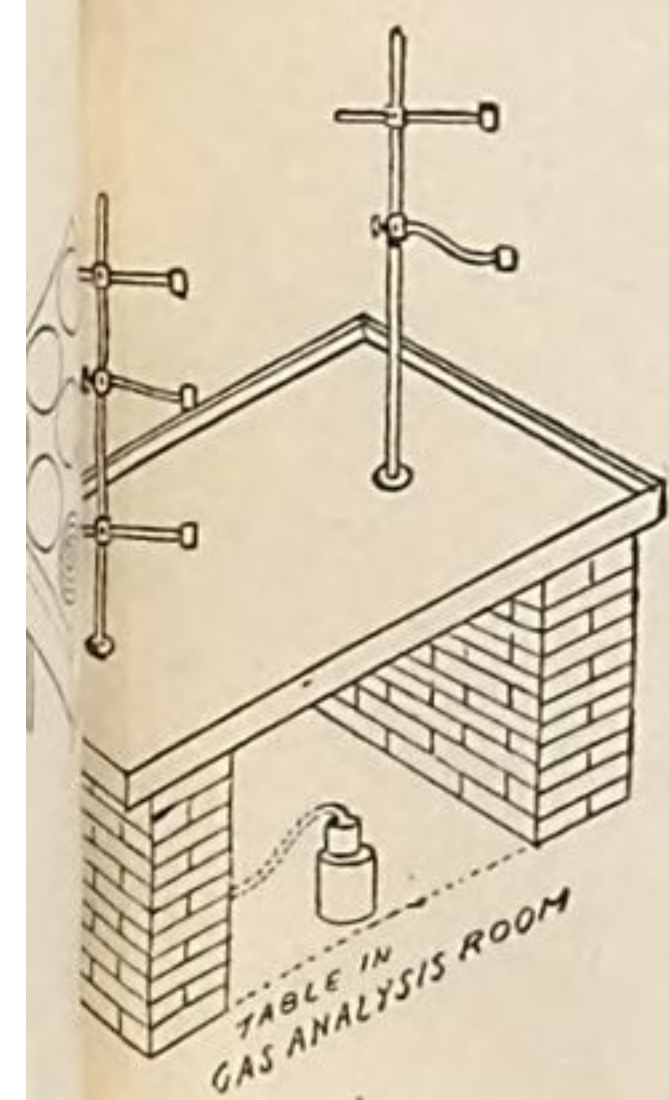
DRAWER
FRONT

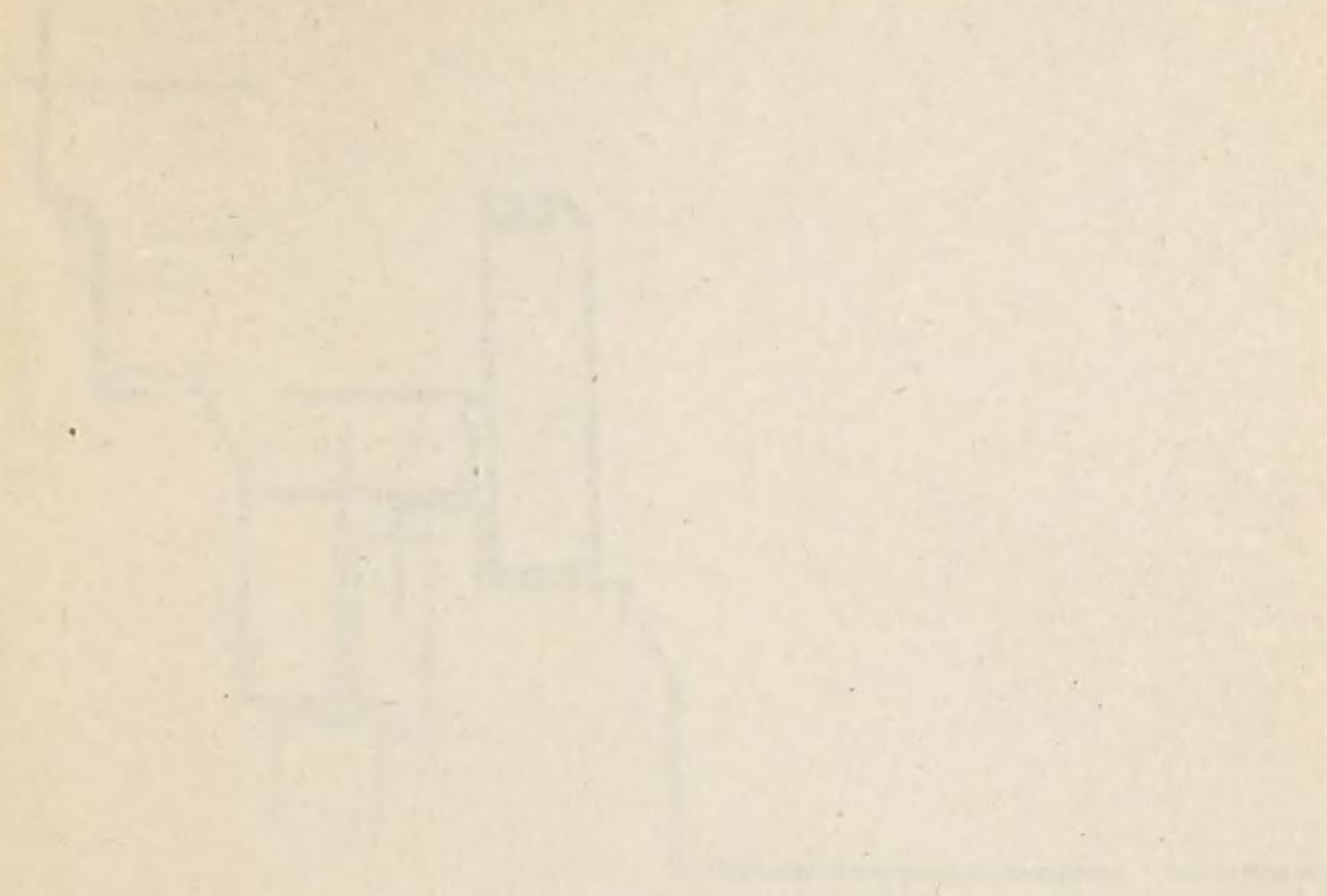
DRAWER TO RUN ON
HARD WOOD TONGUES

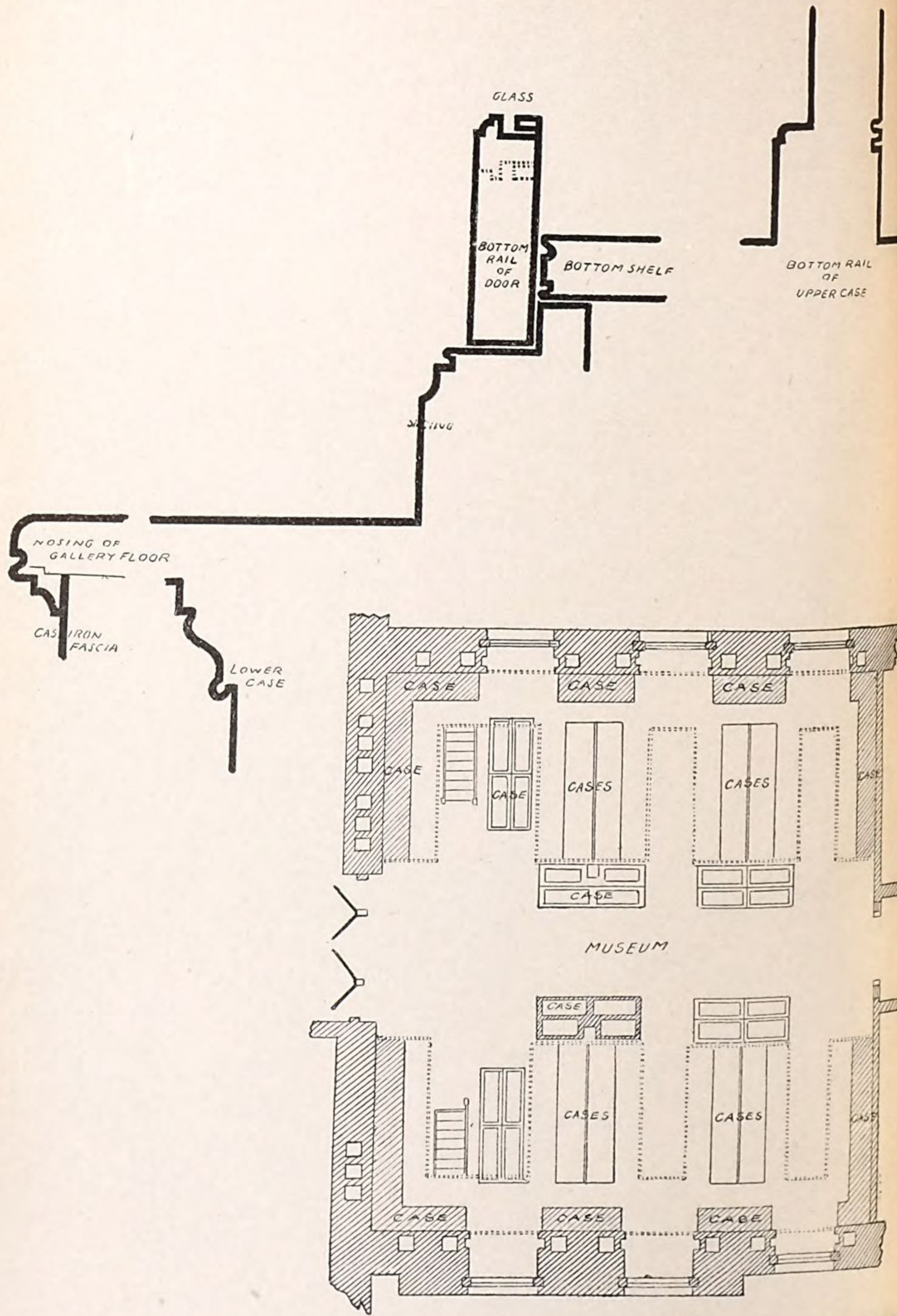
BOTTOM

SLIDING DOOR

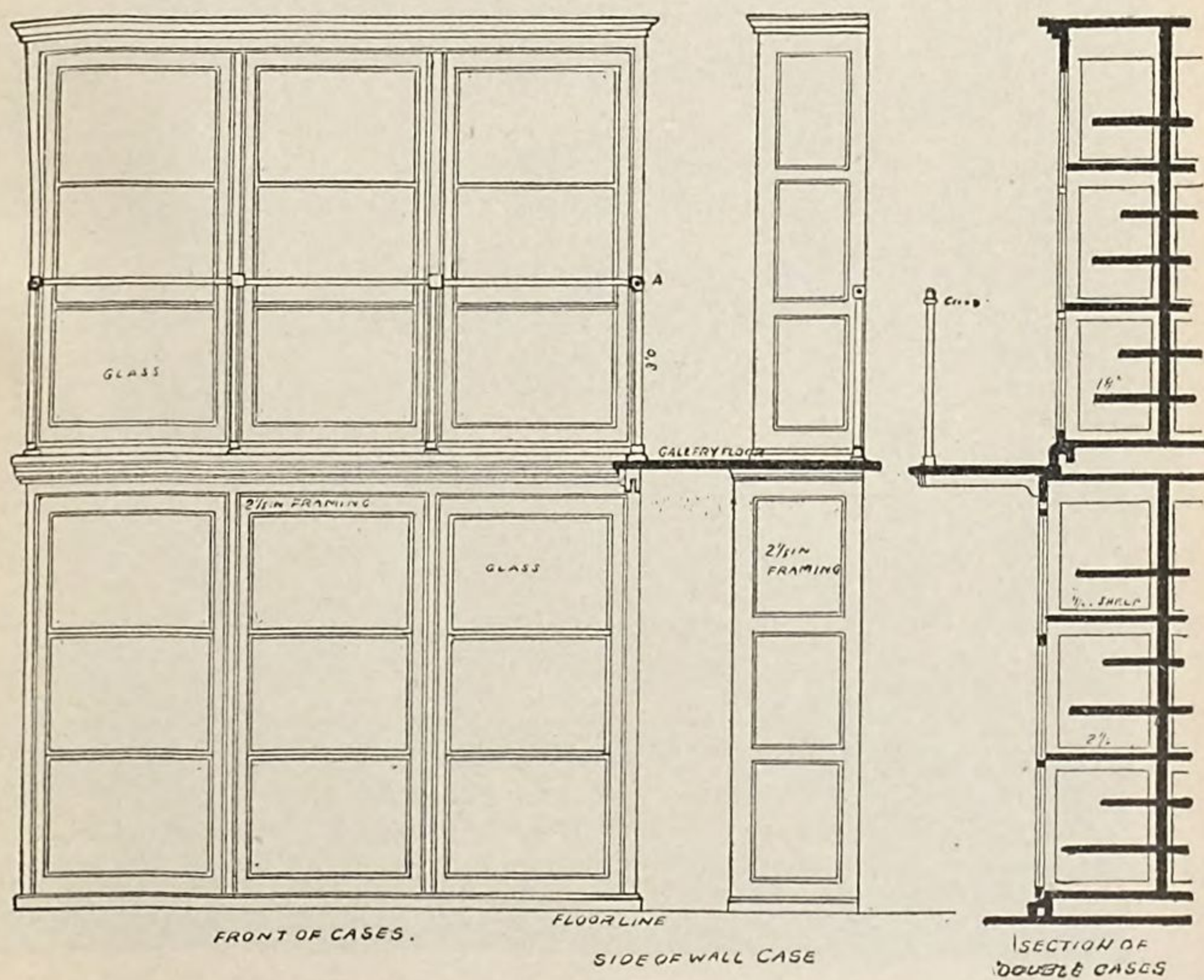
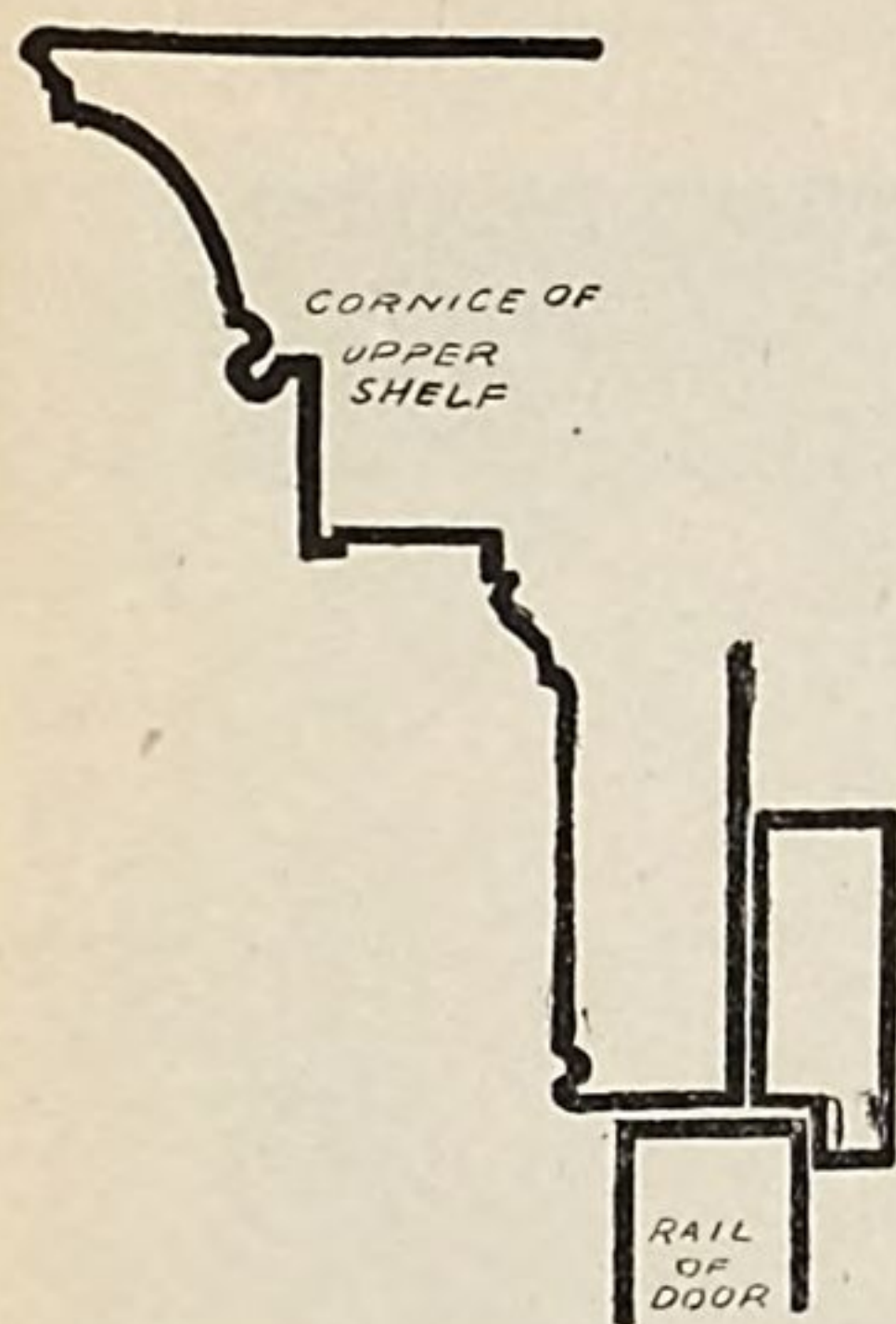
FIXED
PANELS

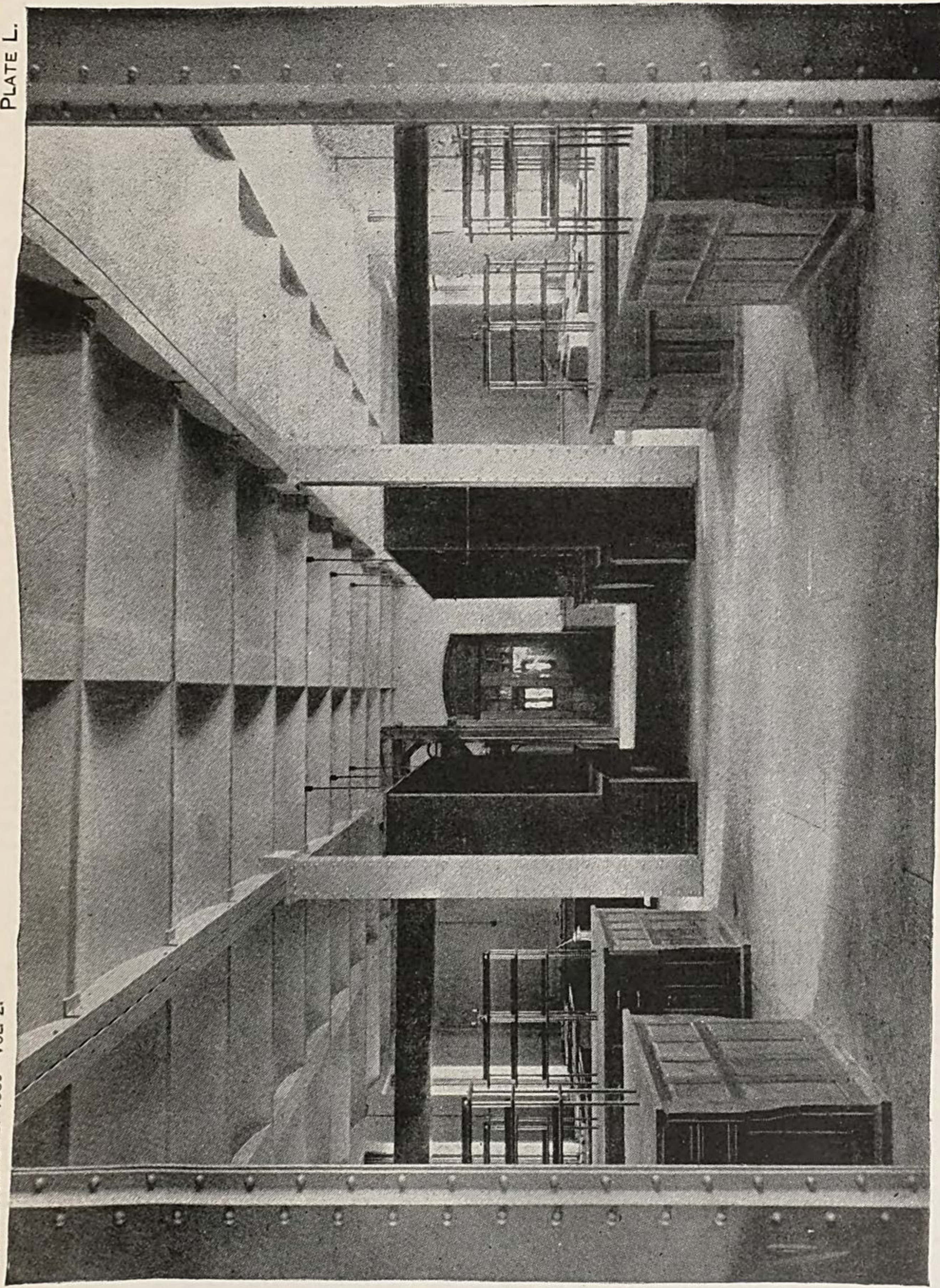




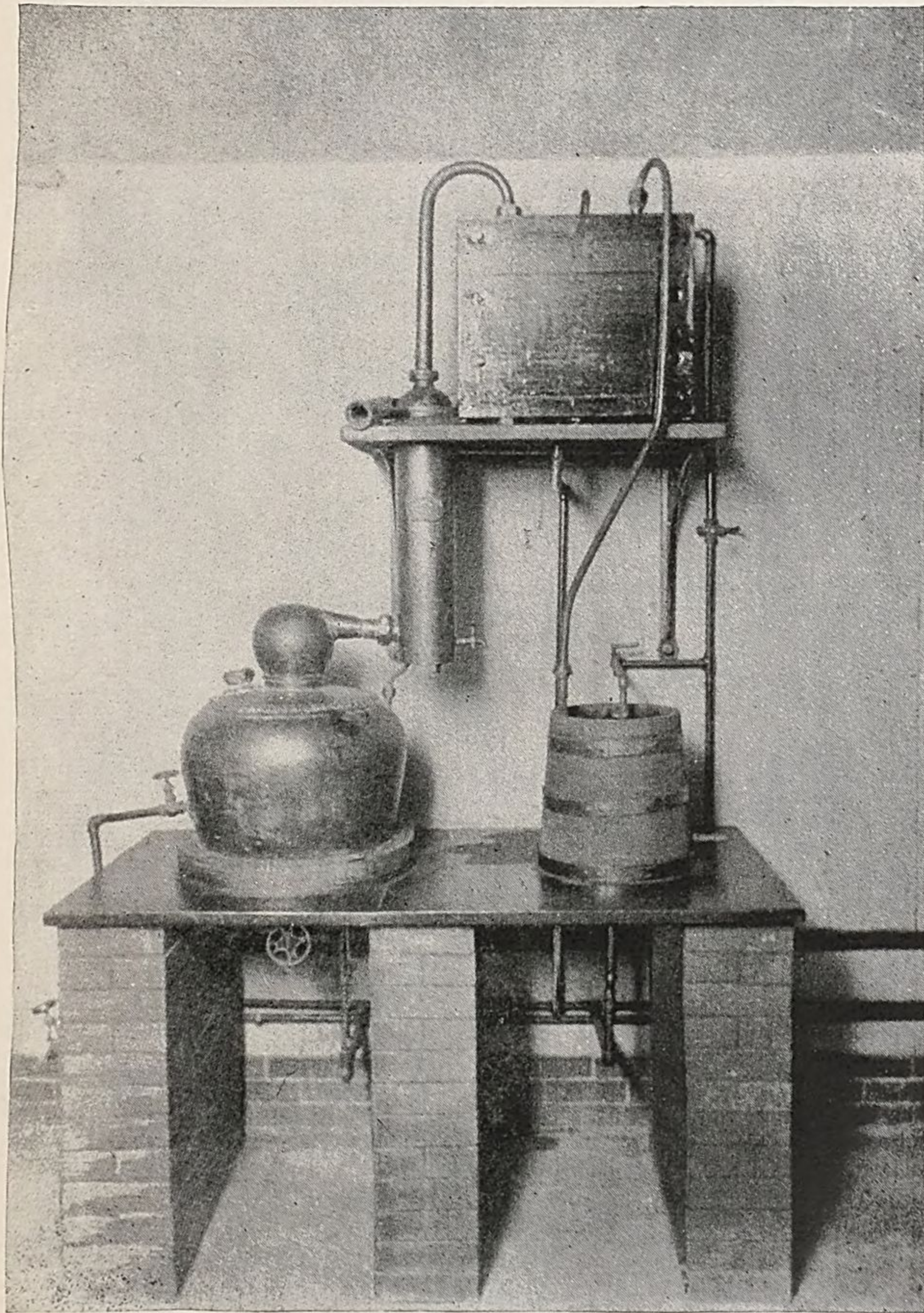


LEHIGH LABORATORY—CASE

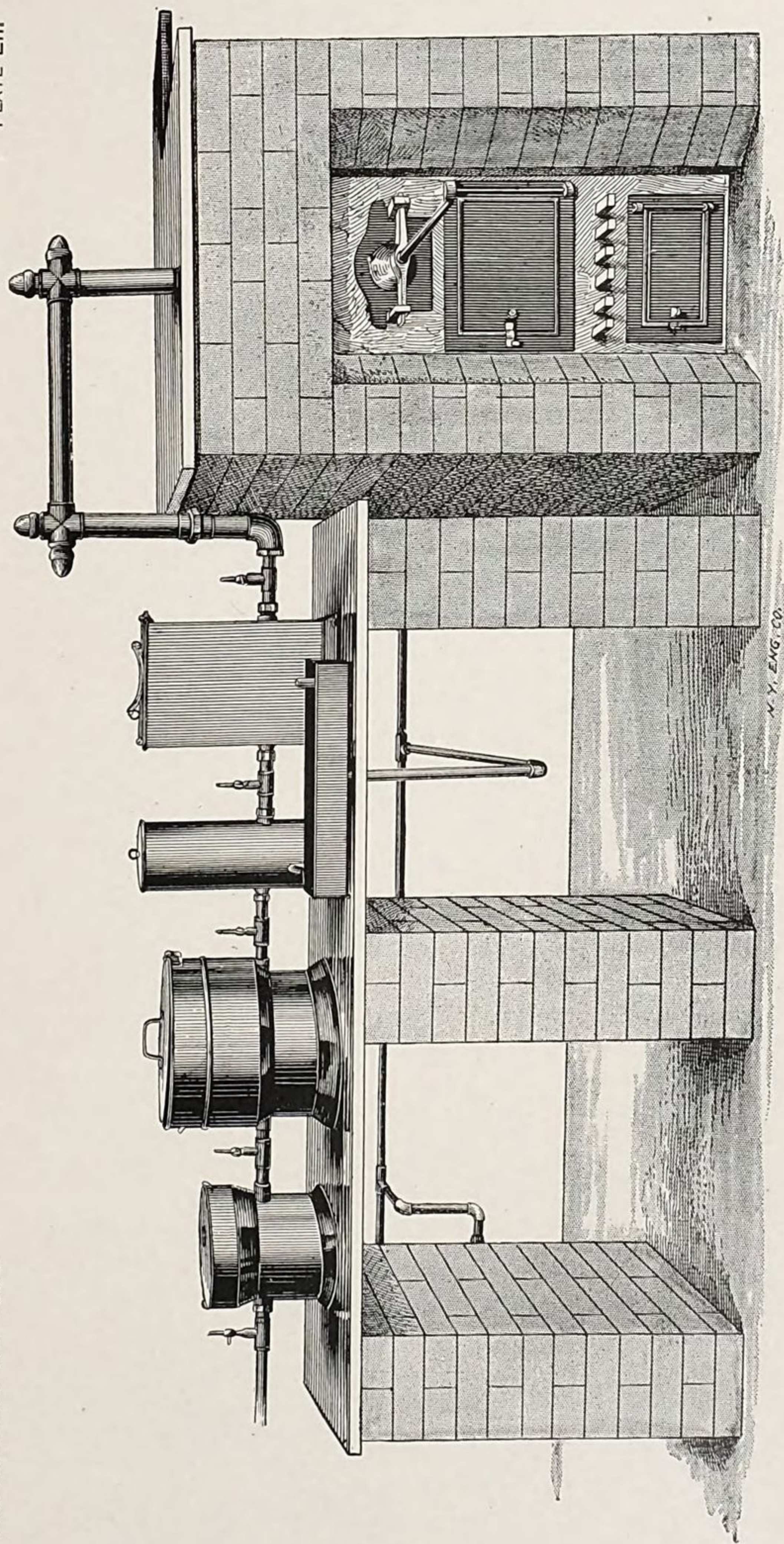




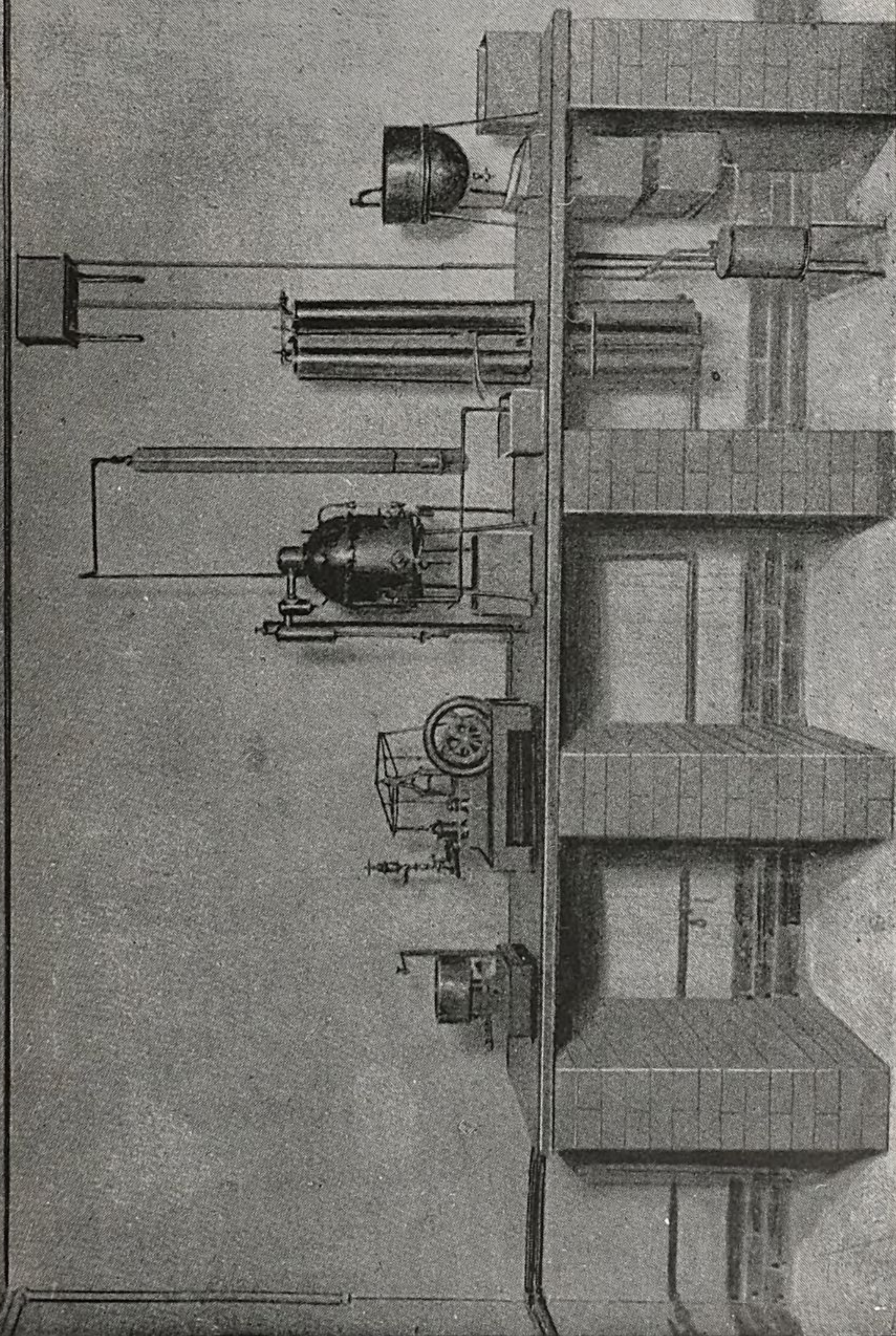
LEHIGH LABORATORY—ASSAY LABORATORY. LOOKING OUTWARD.



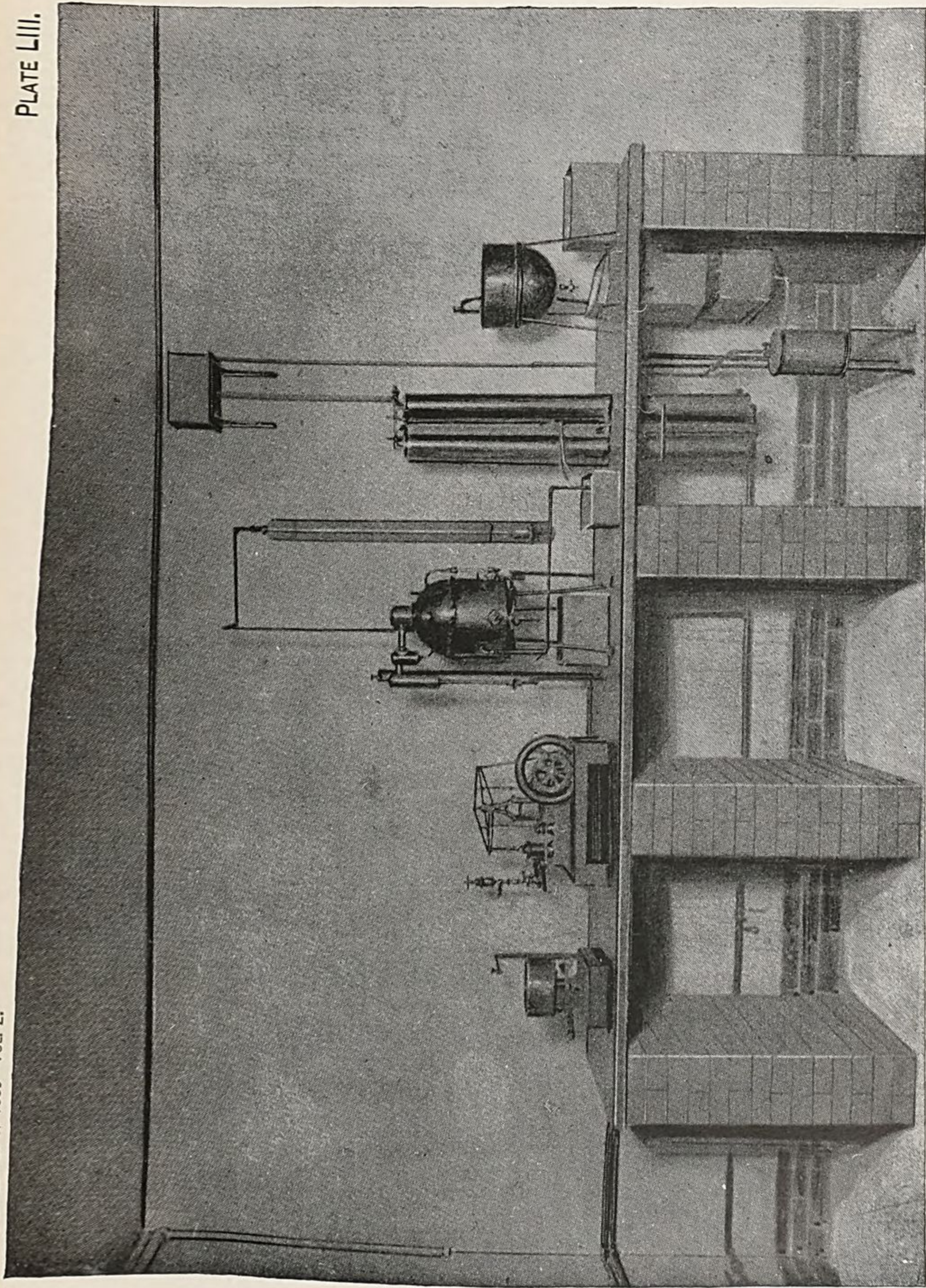
LEHIGH LABORATORY—ALCOHOL STILL.



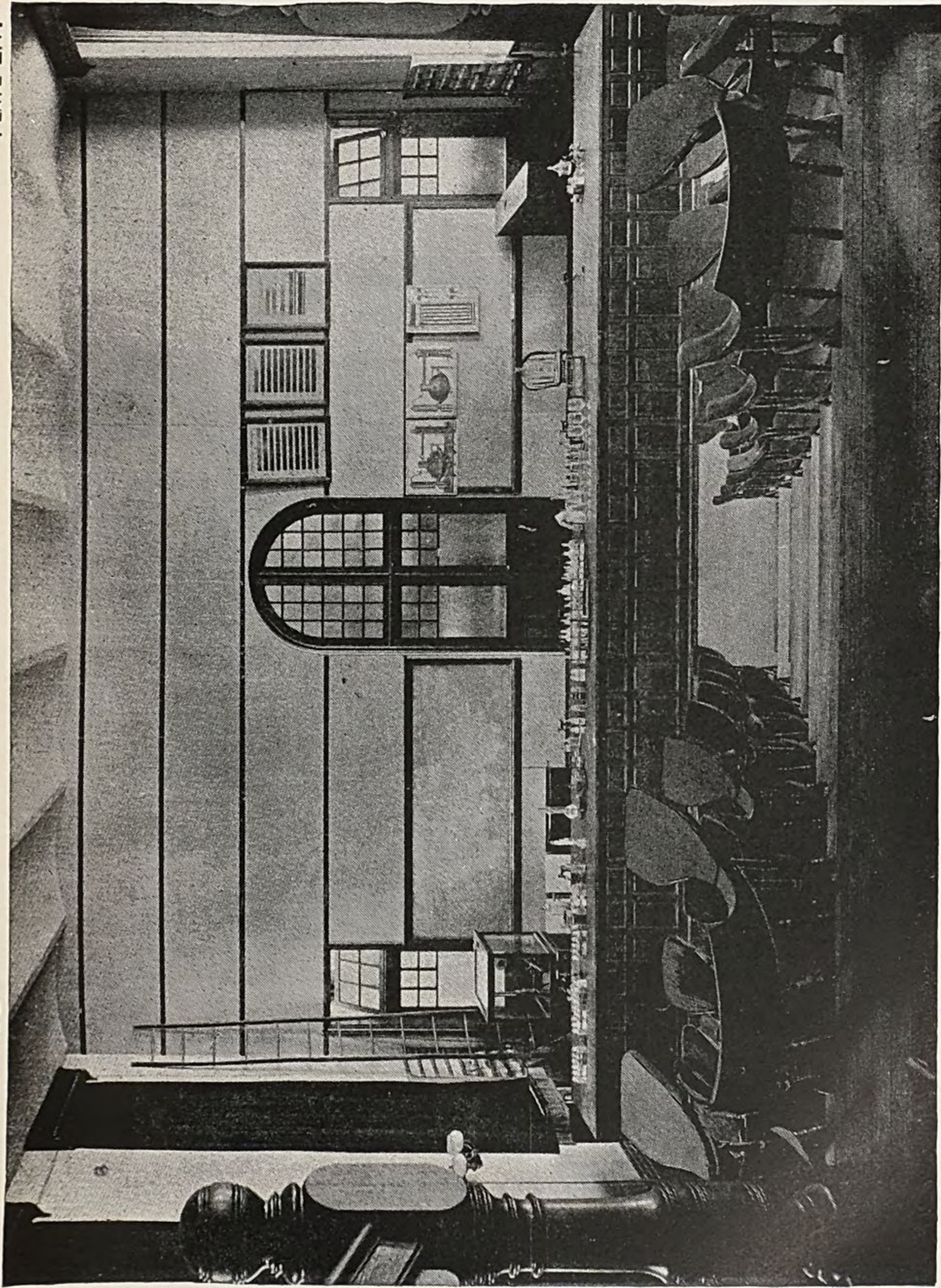
LEHIGH LABORATORY—GAS WORKS MODEL.



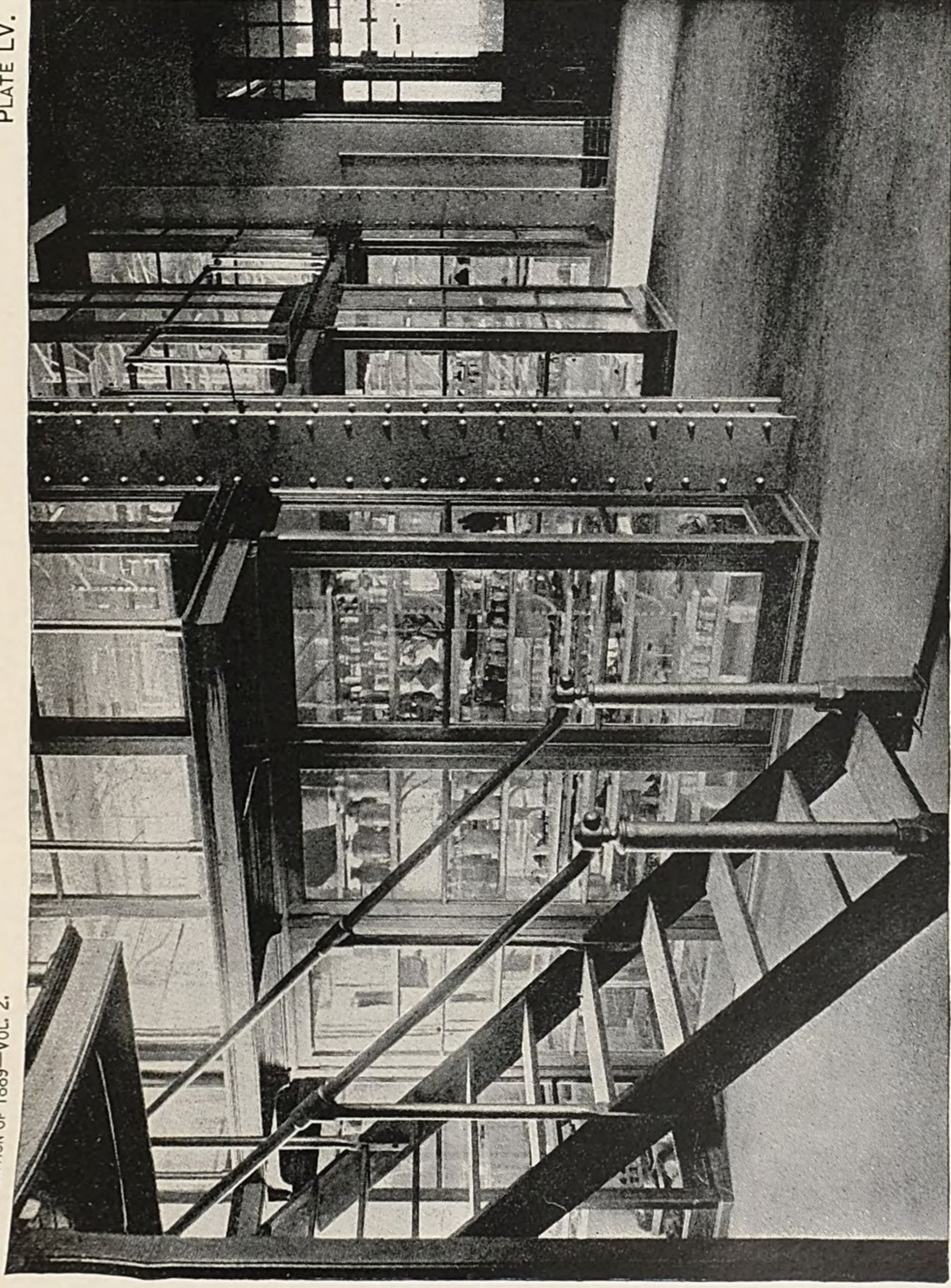
LEHIGH LABORATORY—SUGAR REFINERY MODEL.



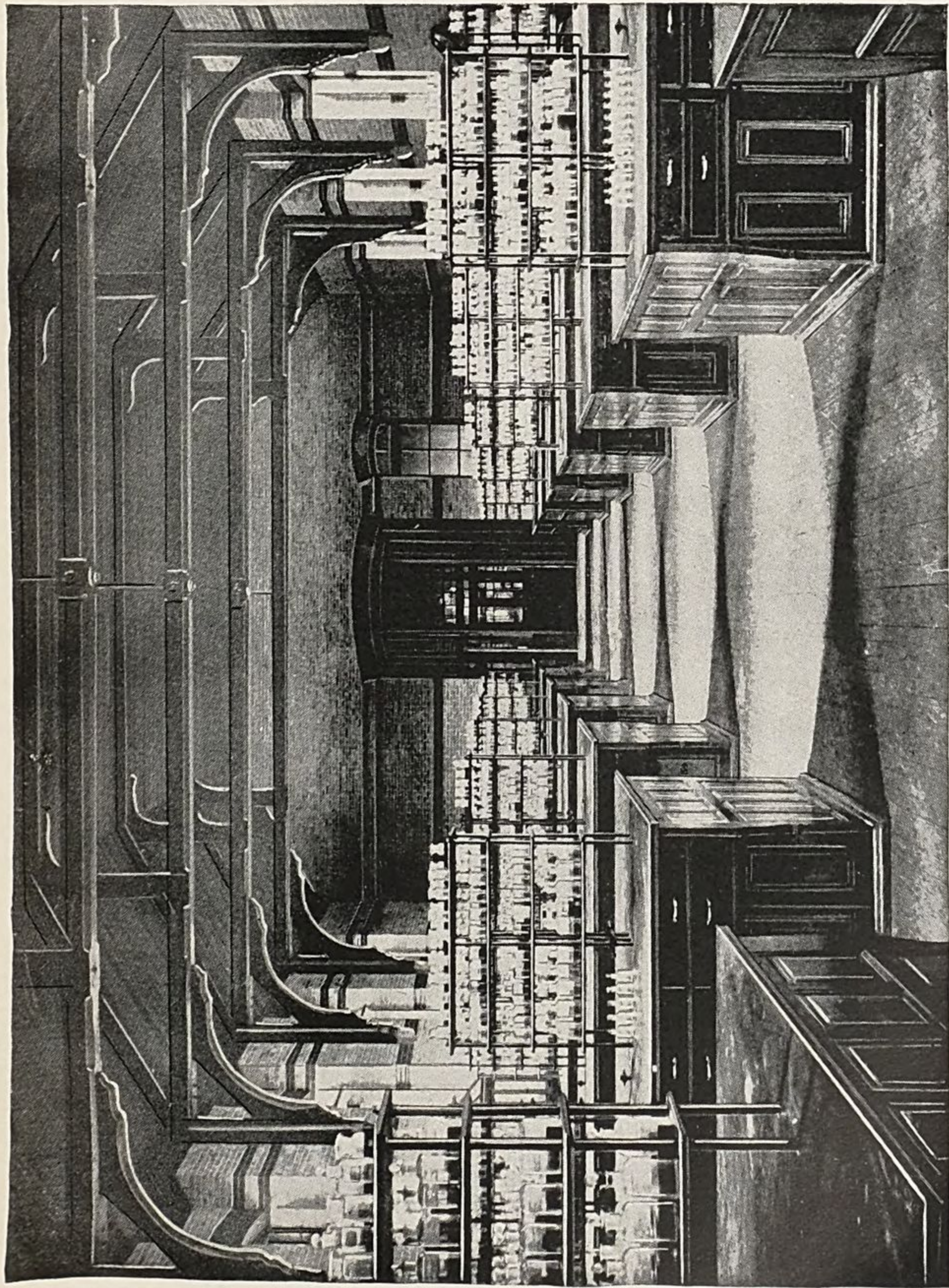
LEHIGH LABORATORY—SUGAR REFINERY MODEL.



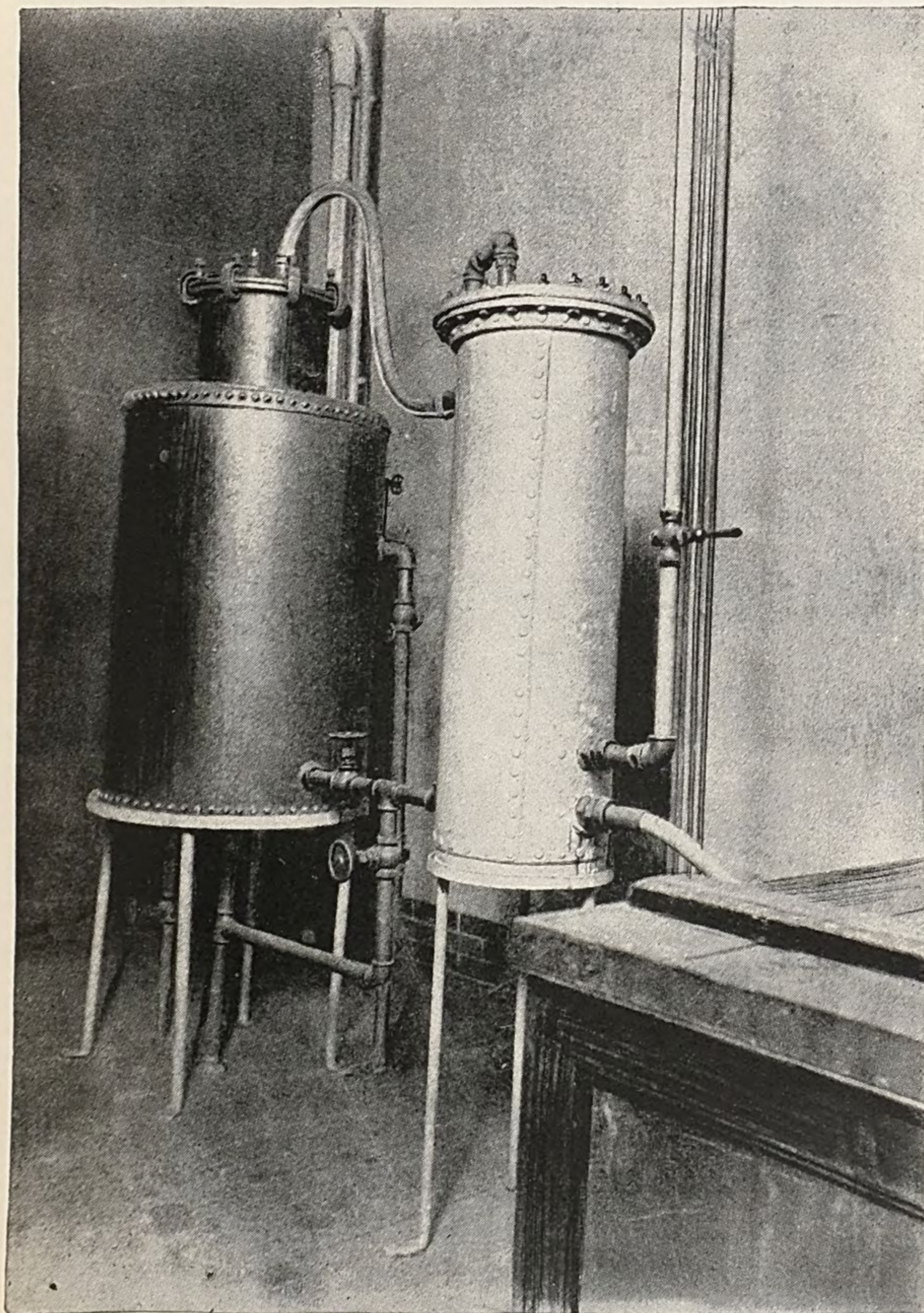
LEHIGH LABORATORY—LECTURE ROOM FOR CHEMISTRY—LOOKING INWARD.



LEHIGH LABORATORY—MUSEUM OF CHEMISTRY. LOOKING INWARD.



LEHIGH LABORATORY—QUALITATIVE ANALYSIS LABORATORY. LOOKING OUTWARD.



LEHIGH LABORATORY—STILL FOR DISTILLING WATER.

building, is by positive air pressure, produced by a large fan. The atmosphere of the laboratories can be changed once in 7 minutes. The exit for the air in the laboratories is through the hoods.

Plates LXII and LXIII show elevations and plans of the desk and fittings in the general laboratory.

Plates LXIV, LXV, LXVI, and LXVII are views of the laboratory of analytical chemistry, a room of the same size as that of the laboratory of general chemistry. It has one hundred and eight desks.

Plates LXIV and LXV show the laboratory from opposite ends; Plate LXVI is a side view showing one of the hoods, and Plate LXVII shows the arrangement of movable desks and the gas, water, suction, and drain pipes.

Plate LXVIII shows the front and end elevation of one of the desks in the analytical laboratory. The division of each working desk into two sets of cupboards and drawers is provided for in case of the necessity of providing for the accommodation of more than one hundred and eight students in this department.

Plate LXIX shows the arrangement of the hoods in the laboratories. The front is fitted with vertically sliding window sashes, reaching down to the shelf.

Plate LXX is the laboratory for volumetric analysis. It is $31\frac{1}{2}$ by $11\frac{1}{2}$ feet, and has accommodations for twenty-one workers.

Plate LXXI is the balance room, of the same size as the volumetric room. It contains twenty-two analytical balances.

Plate LXXII is the chemical library and reading room which connects directly with the analytical and organic laboratories. It contains 4,000 volumes and 2,000 pamphlets. It is $31\frac{1}{2}$ by $16\frac{2}{3}$ feet.

Plate LXXIII is the general organic laboratory; it has places for thirty students. It is 36 by $29\frac{1}{2}$ feet.

Plate LXXIV is the organic furnace room on the roof of the building; it is reached by the flight of stairs shown in Plate LXXIII.

Plate LXXV is the organic laboratory for research. It is $29\frac{1}{2}$ by $18\frac{1}{4}$ feet.

Plate LXXVI is one of the private laboratories. It is $17\frac{1}{2}$ by $14\frac{1}{2}$ feet. There are four of these laboratories for the use of the instructors.

Plate LXXVII is the laboratory of sanitary chemistry. It is $29\frac{1}{2}$ by 25 feet.

Plate LXXVIII is the laboratory for water and gas analysis. It is $39\frac{2}{3}$ by 39 feet.

Plate LXXIX is the chemical lecture room. It is $44\frac{1}{2}$ by $39\frac{1}{2}$ feet, and has a seating capacity of one hundred and eighty.

Plate LXXX is the smaller chemical lecture room, with a seating capacity of thirty.

Plates LXXXI, LXXXII, and LXXXIII are three views in the industrial laboratories. The three rooms used for laboratory instruc-

tion in industrial chemistry communicate directly with each other. They are respectively $32\frac{1}{2}$ by $29\frac{1}{2}$ feet, 14 by $29\frac{1}{2}$ feet, and $29\frac{2}{3}$ by 37 feet. They accommodate thirty students. They are fitted with the needful apparatus for the preparation of chemicals on a considerable scale. The students are taught here the preparation of chemical products from raw materials, the utilization of by-products, and the methods for the purification of chemicals. A special assignment of work is made for each individual, so that the student may see a varied line of work. The laboratory contains kettles of the various patterns, stills, presses, tanks, centrifugal driers, filter press, crystal driers, furnace, and a variety of other apparatus. The laboratory devoted to textile coloring contains numerous jacketed kettles, baths and dye-tubs, squeeze rolls, steamer, ager, and drier, and a printing machine designed for experimental purposes.

Plates LXXXIV and LXXXV are views of the assay laboratory. It is $35\frac{1}{2}$ by $28\frac{1}{4}$ feet. It contains ten crucible furnaces and eight muffle furnaces. It has desks for fifty students.

THE KIDDER CHEMICAL LABORATORIES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, BOSTON, MASSACHUSETTS.

(With 27 plates.)

The course in chemistry is designed primarily to prepare students for actual work in connection with manufactures, based on chemical principles. It is also adapted to the needs of those who intend to become teachers of chemistry.

The class-room work consists of a course of lectures on general chemistry extending throughout the entire year, and lectures on theoretical, analytical, industrial, and organic chemistry. The non-chemical studies, such as mathematics, physics, mineralogy, English history, political economy, and language, are selected with reference to their bearing on chemical work or for their educational value.

The student spends a large part of the four years in the laboratories, the work being arranged as follows: In the first year there is general laboratory practice, in which the student is taught the nature of chemical processes and the use of chemical apparatus, and is drilled in accurate habits of observation. Analytical chemistry, qualitative and quantitative, is begun in the second year, and continues throughout the course. Industrial, sanitary, and organic laboratory practice follow in the third and fourth years. While there is a certain prescribed course of study and work in the separate departments of chemistry, which all regular students must pursue; there is allowed great latitude in choice of subjects in the third and fourth years. Effort is made to develop self-reliance in the student, so that he may be fitted to make his way without assistance. To this end he is required to make investigations, involving original research and reference to the appropriate literature in English, French, and German.

The Kidder laboratories were built in 1883 and afford accommodations for five hundred and fifty students. There are fifteen laboratories, two lecture rooms, a library and reading room, balance room, offices, and a supply room—in all, twenty-five rooms.

Pl. LIX is the plan of the fourth floor, and Pl. LX is the plan of the third floor of the new building, containing the Kidder laboratories of chemistry.

Pl. LXI is the laboratory of general chemistry with accommodations for three hundred and twenty students. Each desk has two sets of cupboards and drawers below it, so that it may be used by two students. It can thus accommodate in all three hundred and twenty students, and one hundred and sixty can work in the laboratory at the same time. The room is $84\frac{1}{2}$ feet long and $39\frac{1}{2}$ feet wide, and is lighted on three sides. Much of the wall space is occupied by hoods. The ventilation of this laboratory, as well as all the rooms in this

building, is by positive air pressure, produced by a large fan. The atmosphere of the laboratories can be changed once in 7 minutes. The exit for the air in the laboratories is through the hoods.

Plates LXII and LXIII show elevations and plans of the desk and fittings in the general laboratory.

Plates LXIV, LXV, LXVI, and LXVII are views of the laboratory of analytical chemistry, a room of the same size as that of the laboratory of general chemistry. It has one hundred and eight desks.

Plates LXIV and LXV show the laboratory from opposite ends; Plate LXVI is a side view showing one of the hoods, and Plate LXVII shows the arrangement of movable desks and the gas, water, suction, and drain pipes.

Plate LXVIII shows the front and end elevation of one of the desks in the analytical laboratory. The division of each working desk into two sets of cupboards and drawers is provided for in case of the necessity of providing for the accommodation of more than one hundred and eight students in this department.

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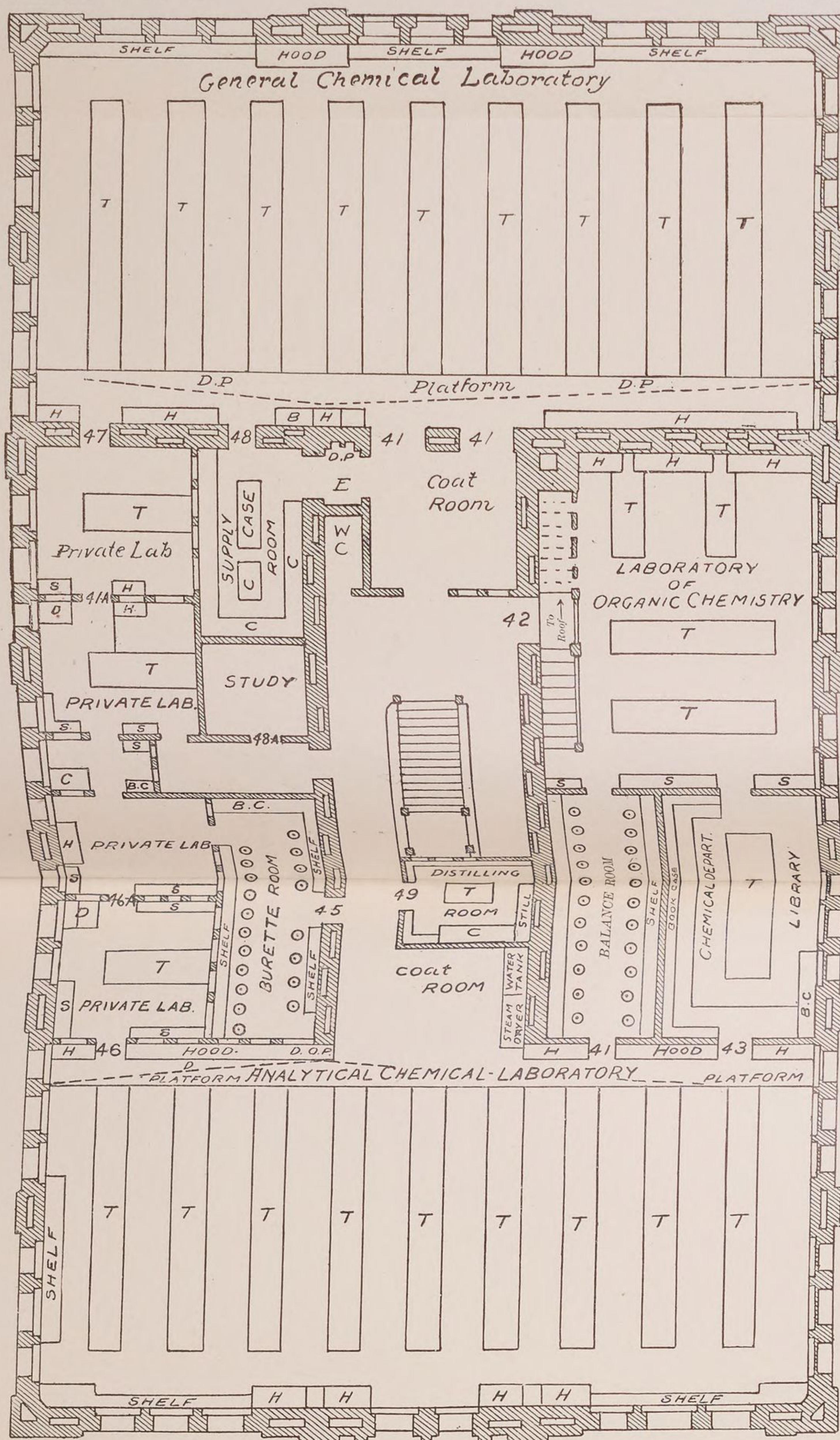
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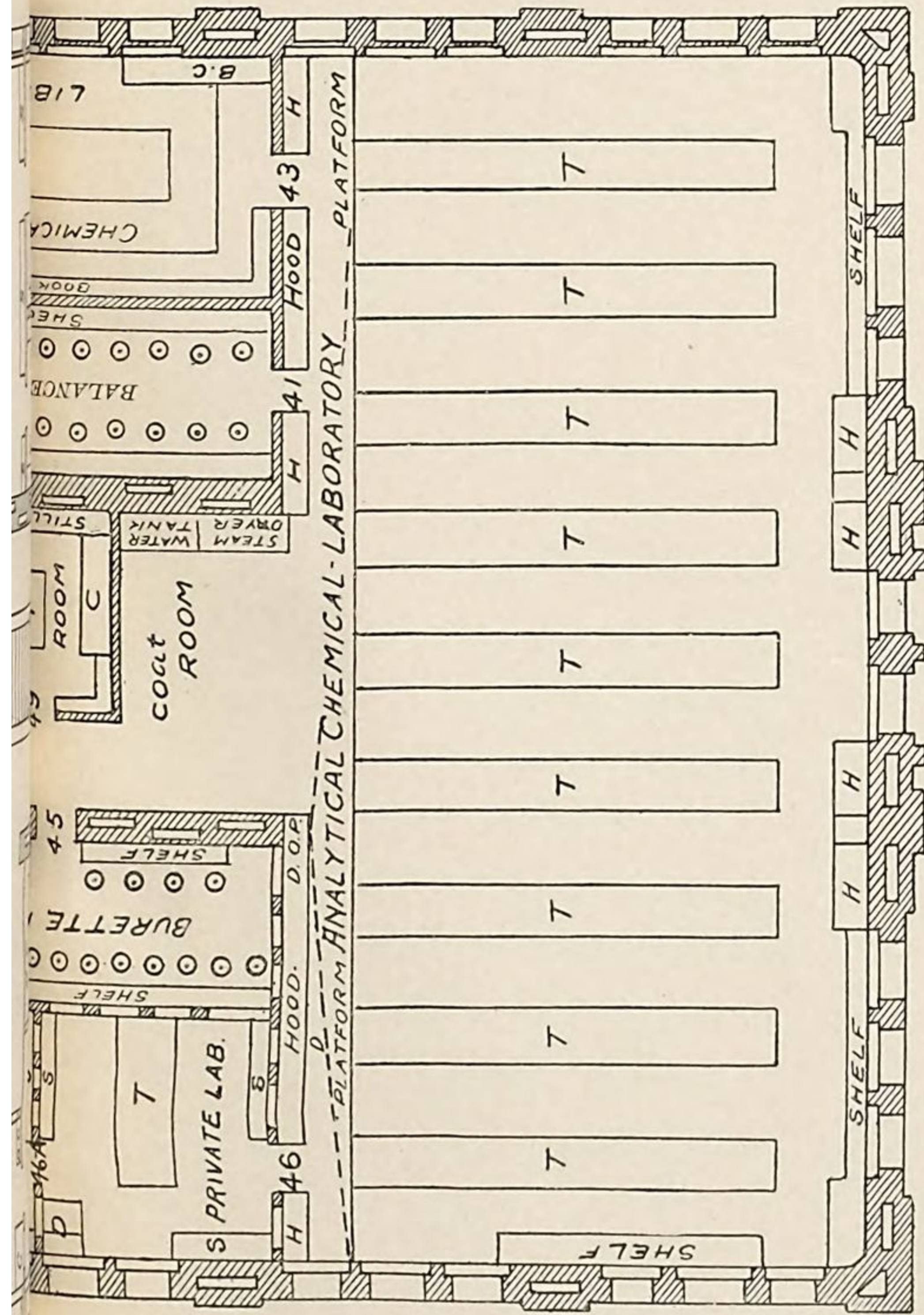
Plan of Fourth Floor of New Building
Scale 1 in = 16 feet.

T. Table
C. Case
H. Hood

E Elevator
D.P. Drainage Pipe
B.C. Book Case

D. Desk
W.S. Wall Shelf
D.C. Draw Case

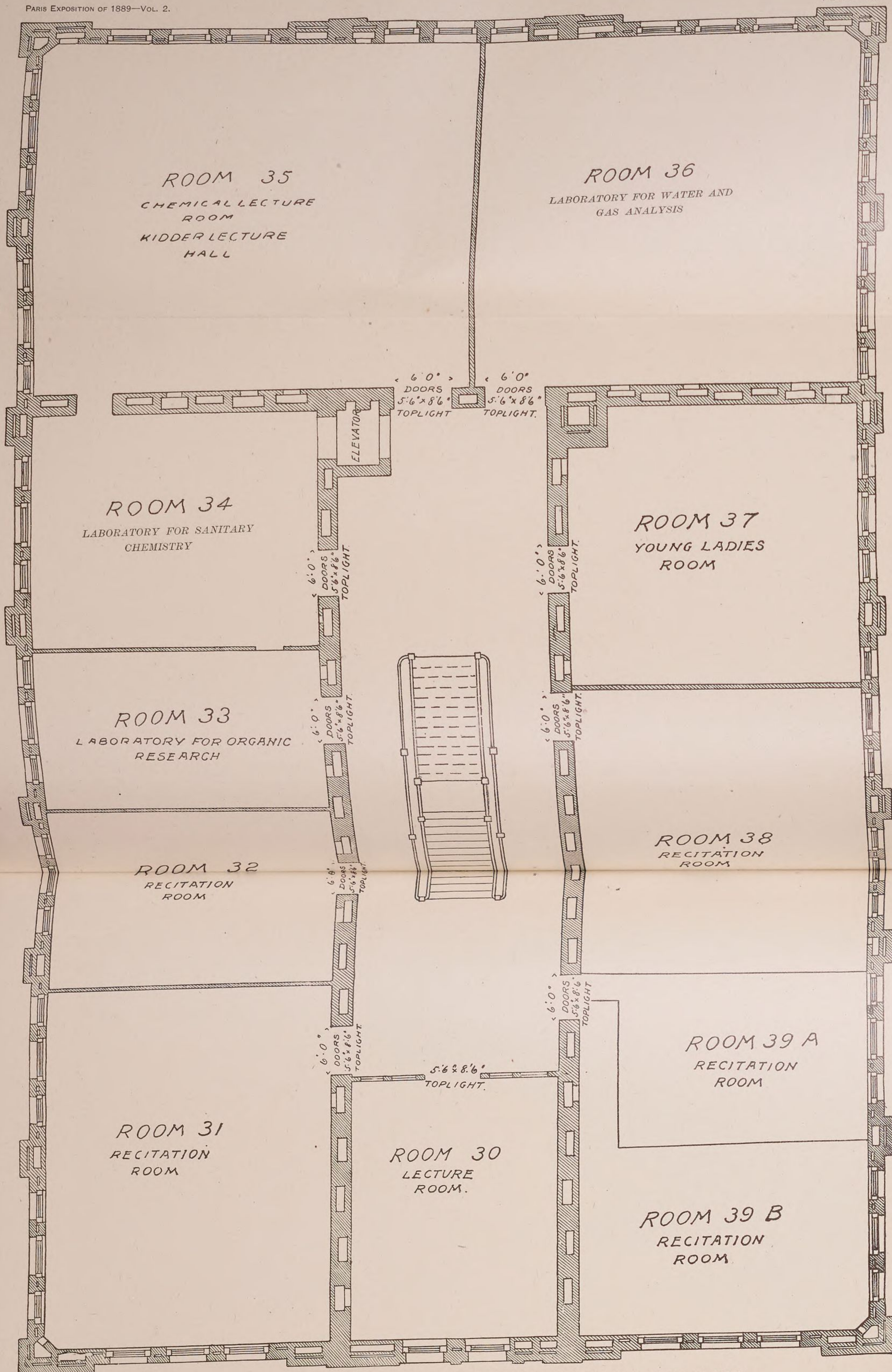
MASSACHUSETTS INSTITUTE OF TECHNOLOGY, BOSTON, MASSACHUSETTS.



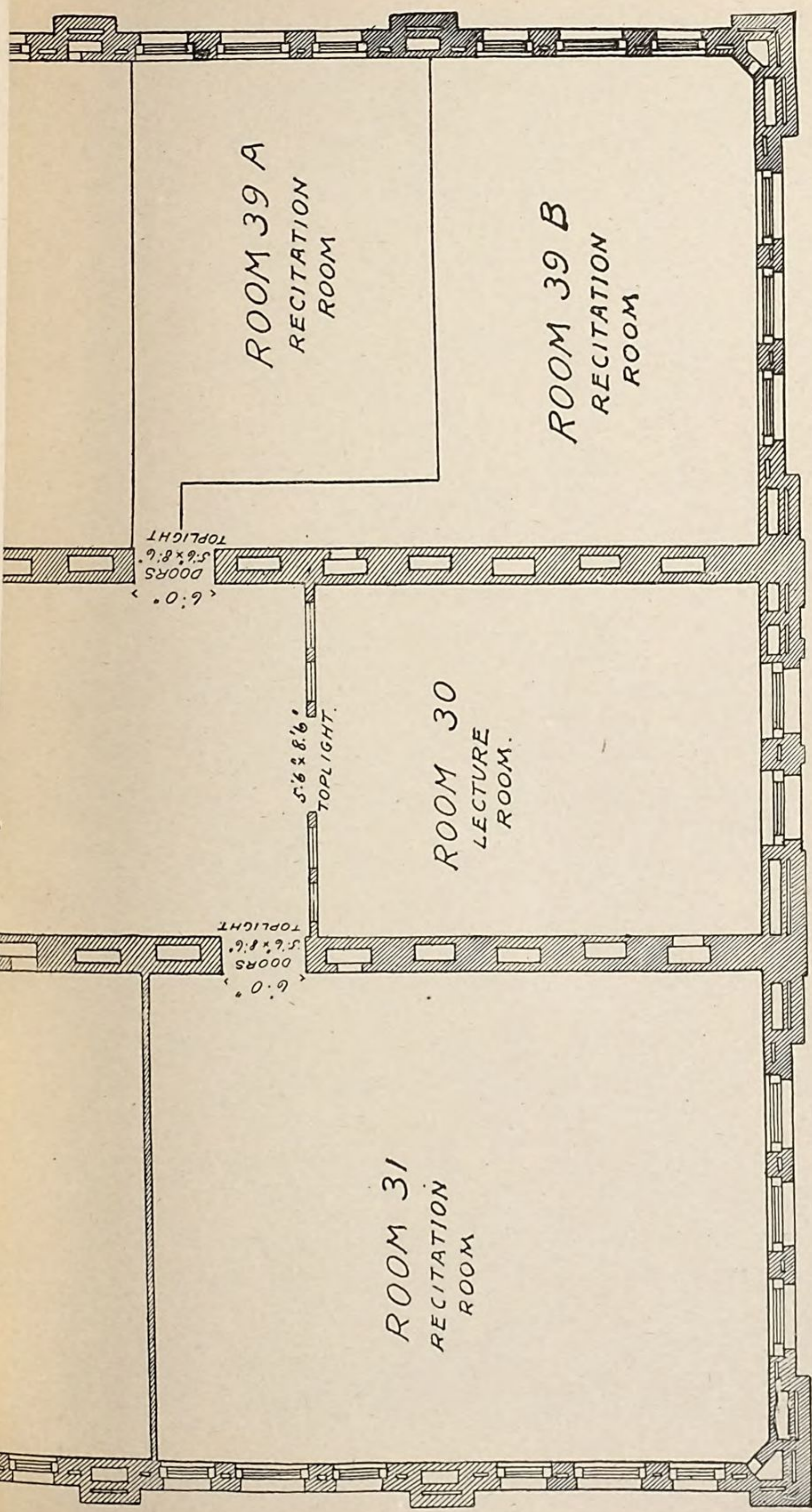
Plan of Fourth Floor of New Building
Scale 1 in = 16 feet.

- | | | |
|----------|------------------|------------------|
| T. Table | E. Elevator | D. Desk |
| C. Case | DP Drainage Pipe | W. S. Wall Shelf |
| H. Hood | B. C. Book Case | D. C. Draw Case |

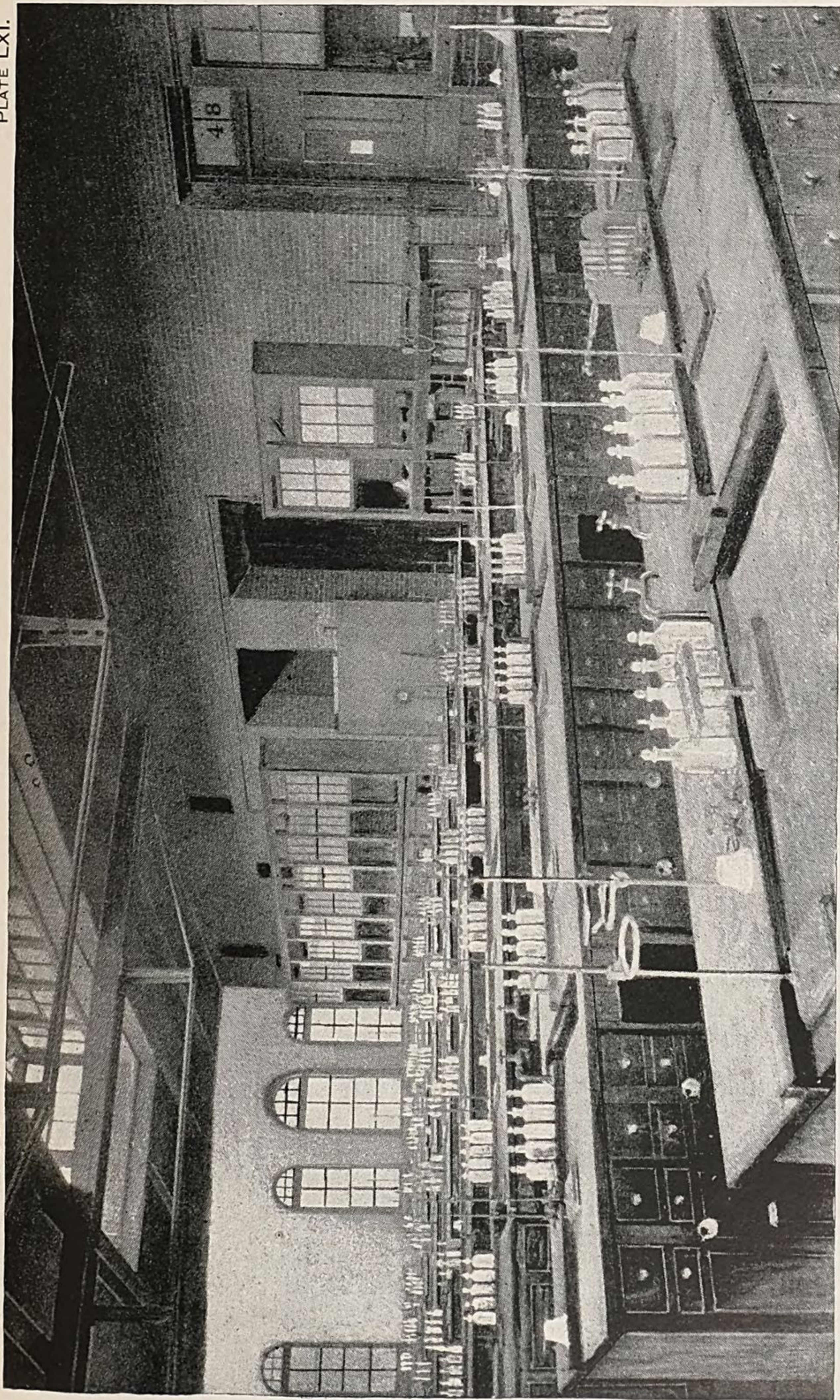
MASSACHUSETTS INSTITUTE OF TECHNOLOGY, BOSTON, MASSACHUSETTS.



MASSACHUSETTS INSTITUTE OF TECHNOLOGY—PLAN OF THIRD FLOOR OF NEW BUILDING.

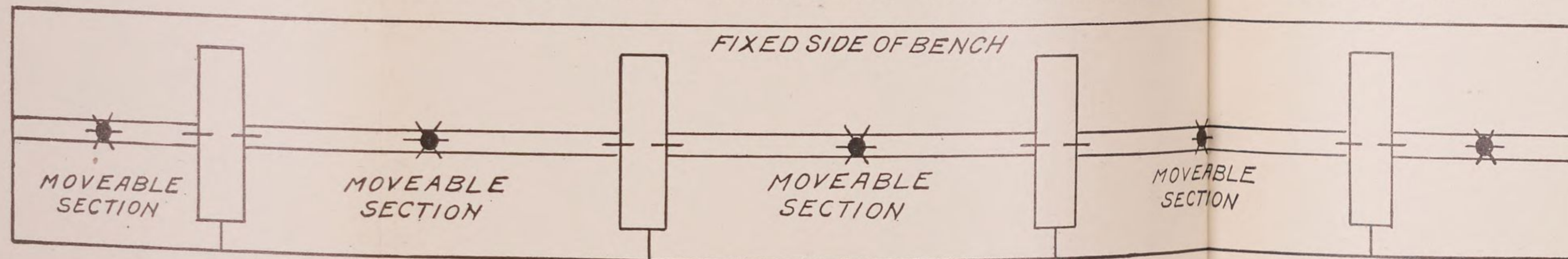


MASSACHUSETTS INSTITUTE OF TECHNOLOGY—PLAN OF THIRD FLOOR OF NEW BUILDING.



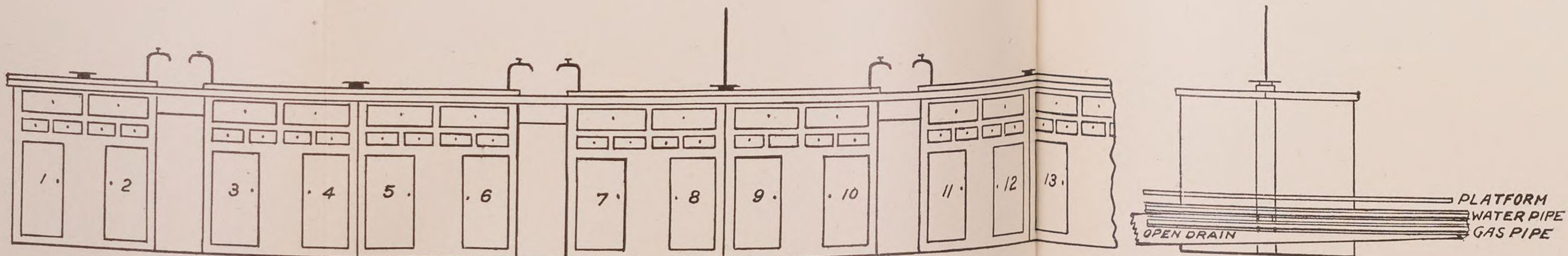
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—LABORATORY OF GENERAL CHEMISTRY.

(One side of the desk is made in one piece, and to this side the fixtures are attached. The other side is divided into five sections, which can be removed in order to gain access to the fixtures.)

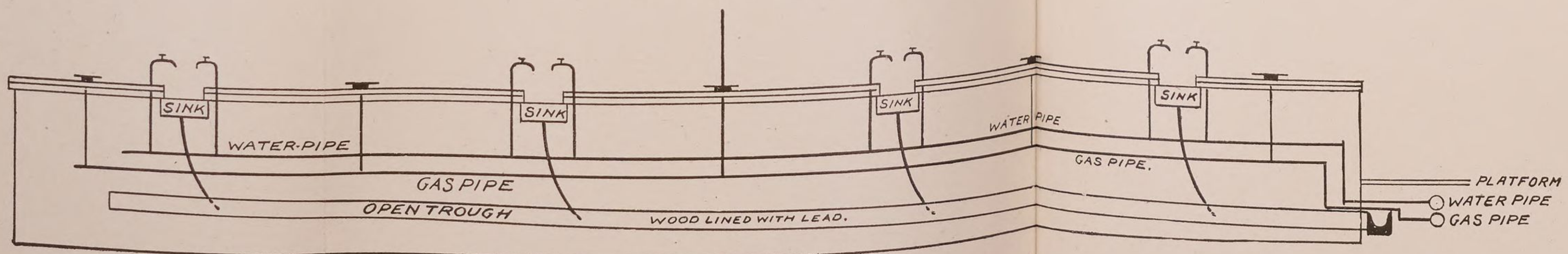


Front Elevation.

End Elevation.



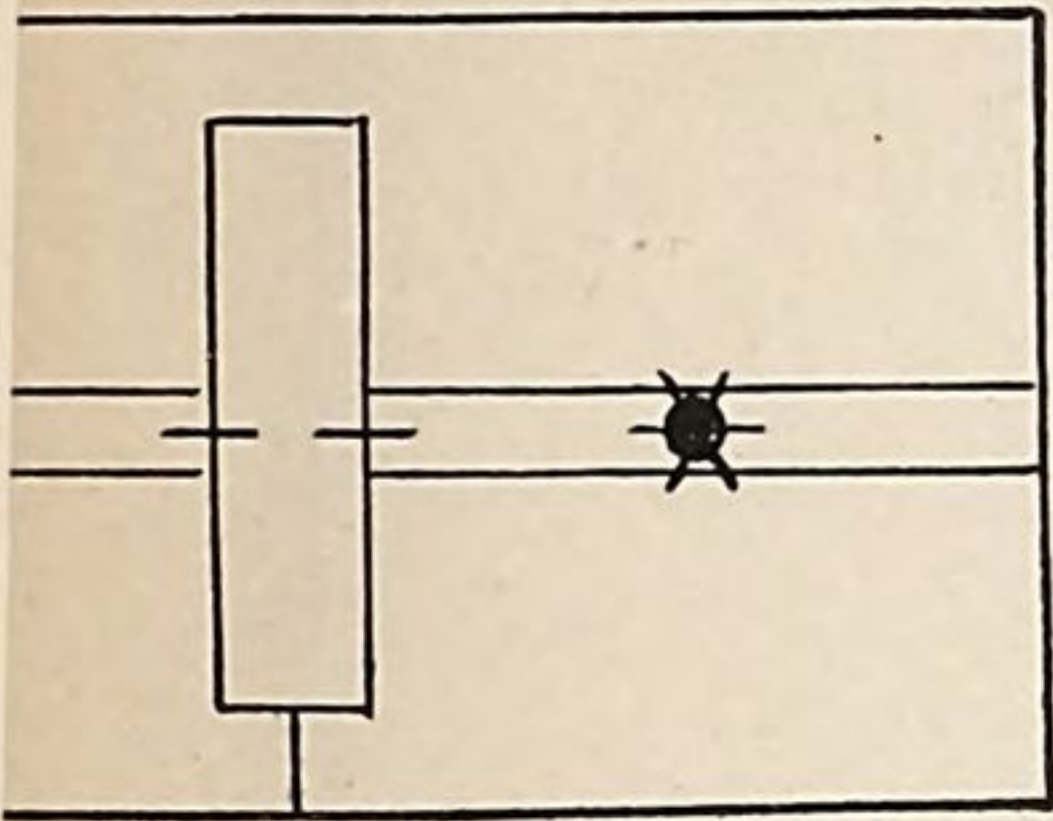
Longitudinal section, showing gas and water pipes and open trough.



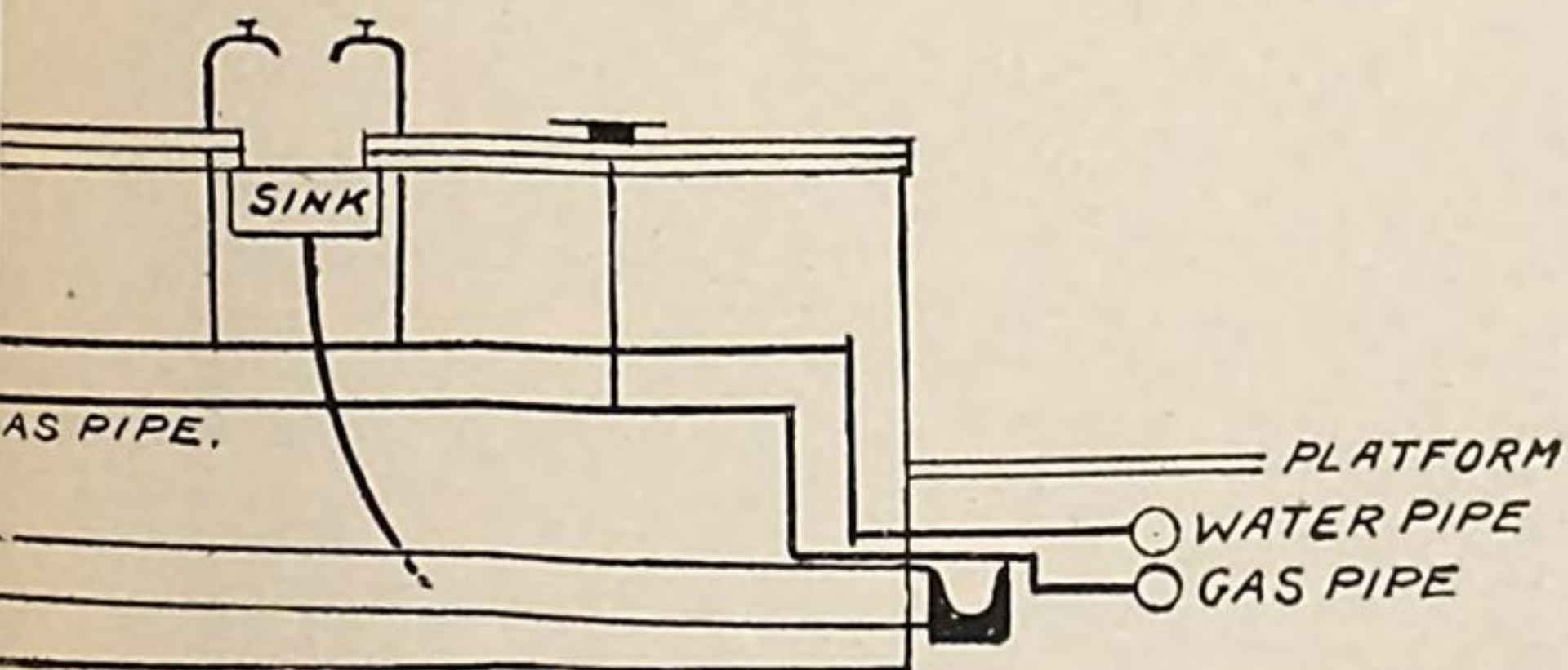
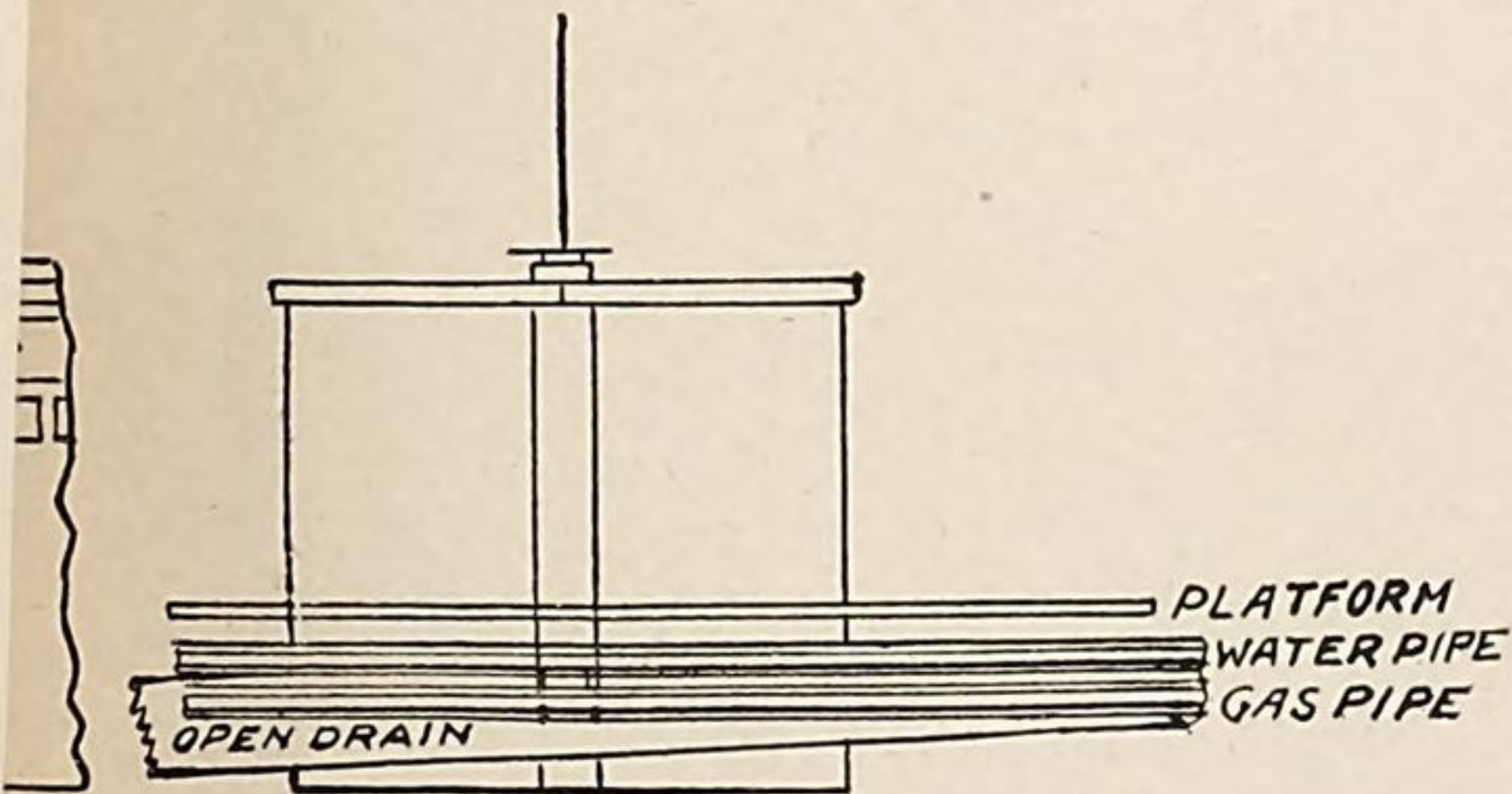
Scale $\frac{1}{8}$ in. = 1 ft.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—DESK OF LABORATORY OF GENERAL CHEMISTRY.

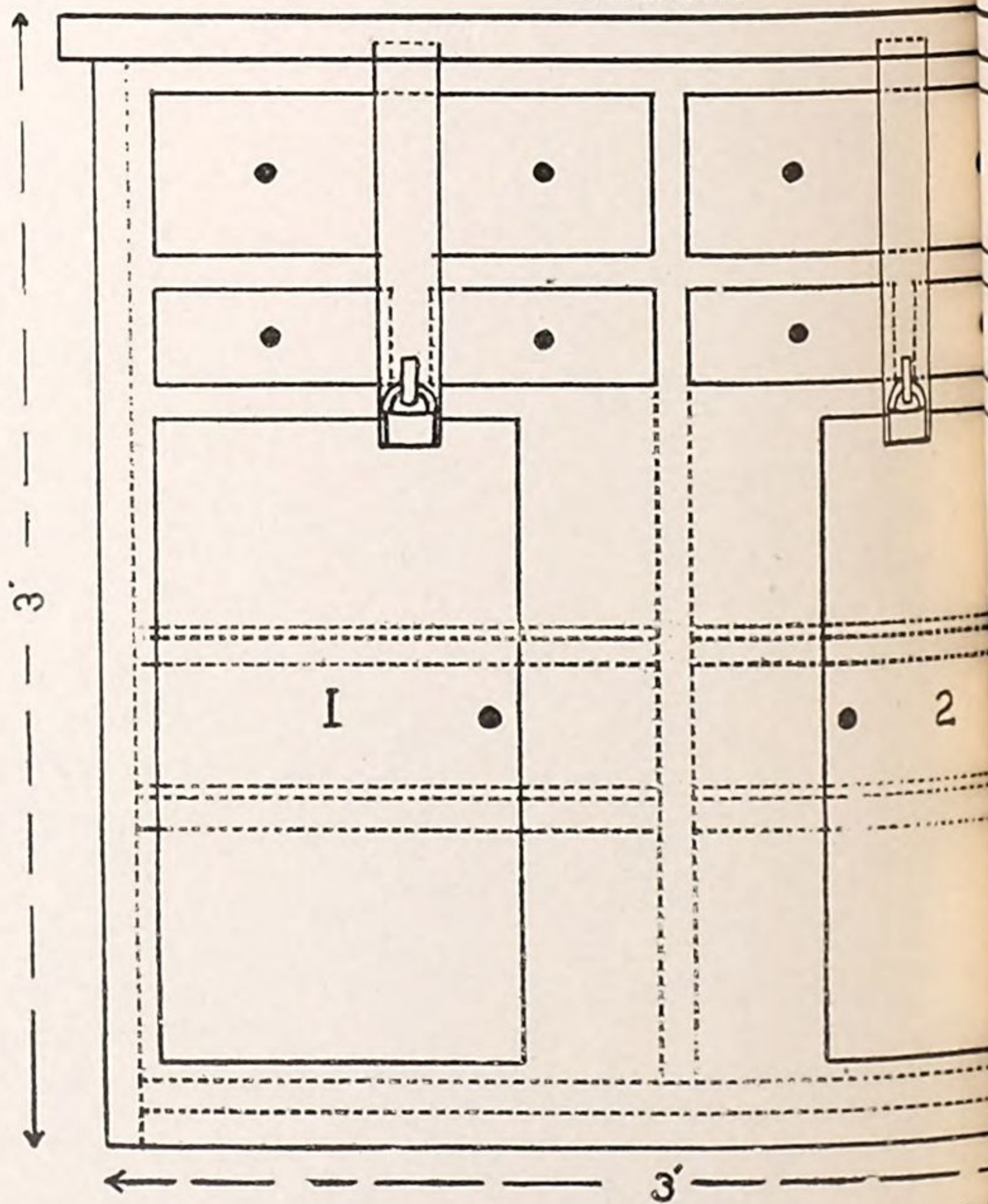
order to gain access to the fixtures.)



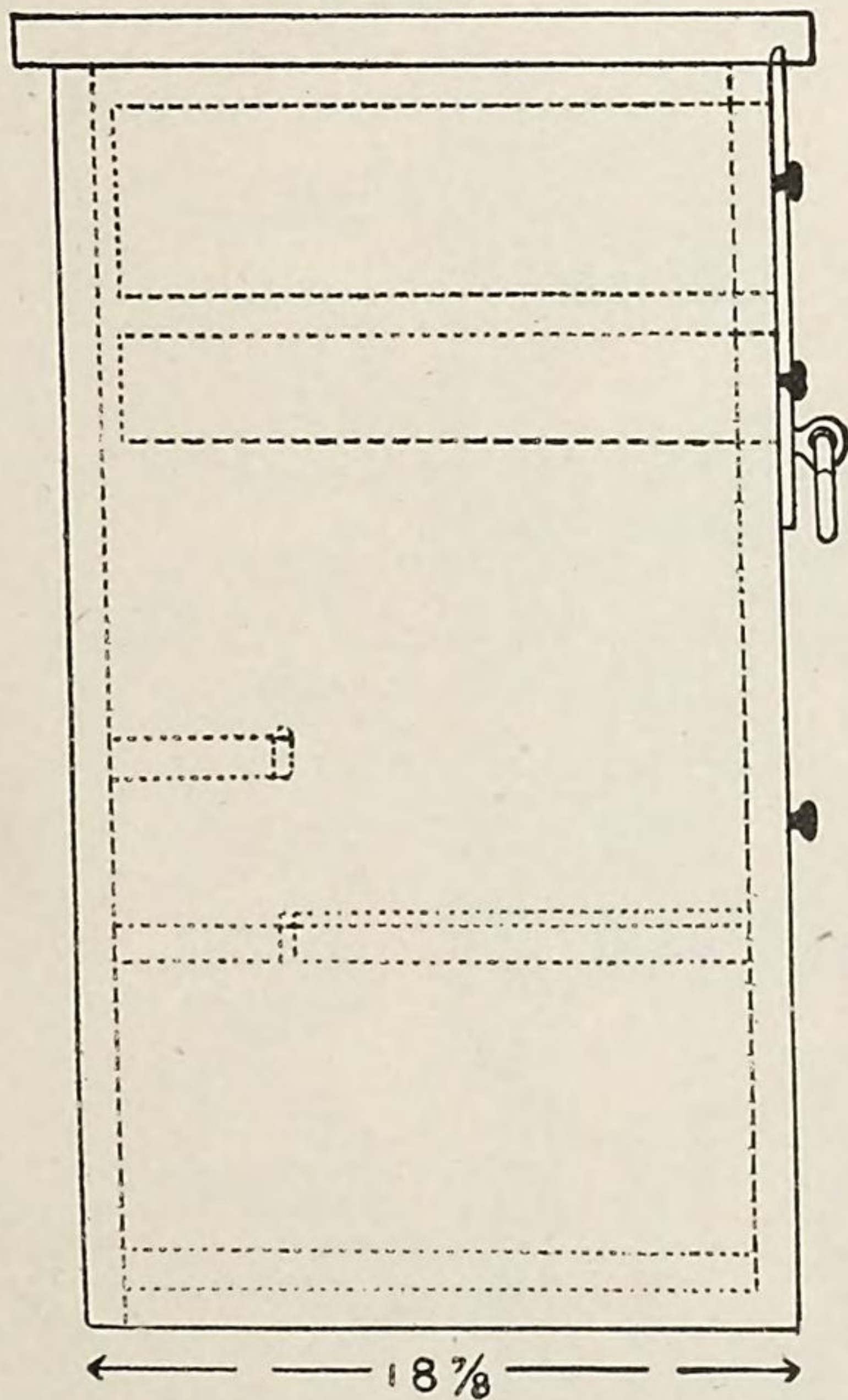
End Elevation.



EMISTRY.

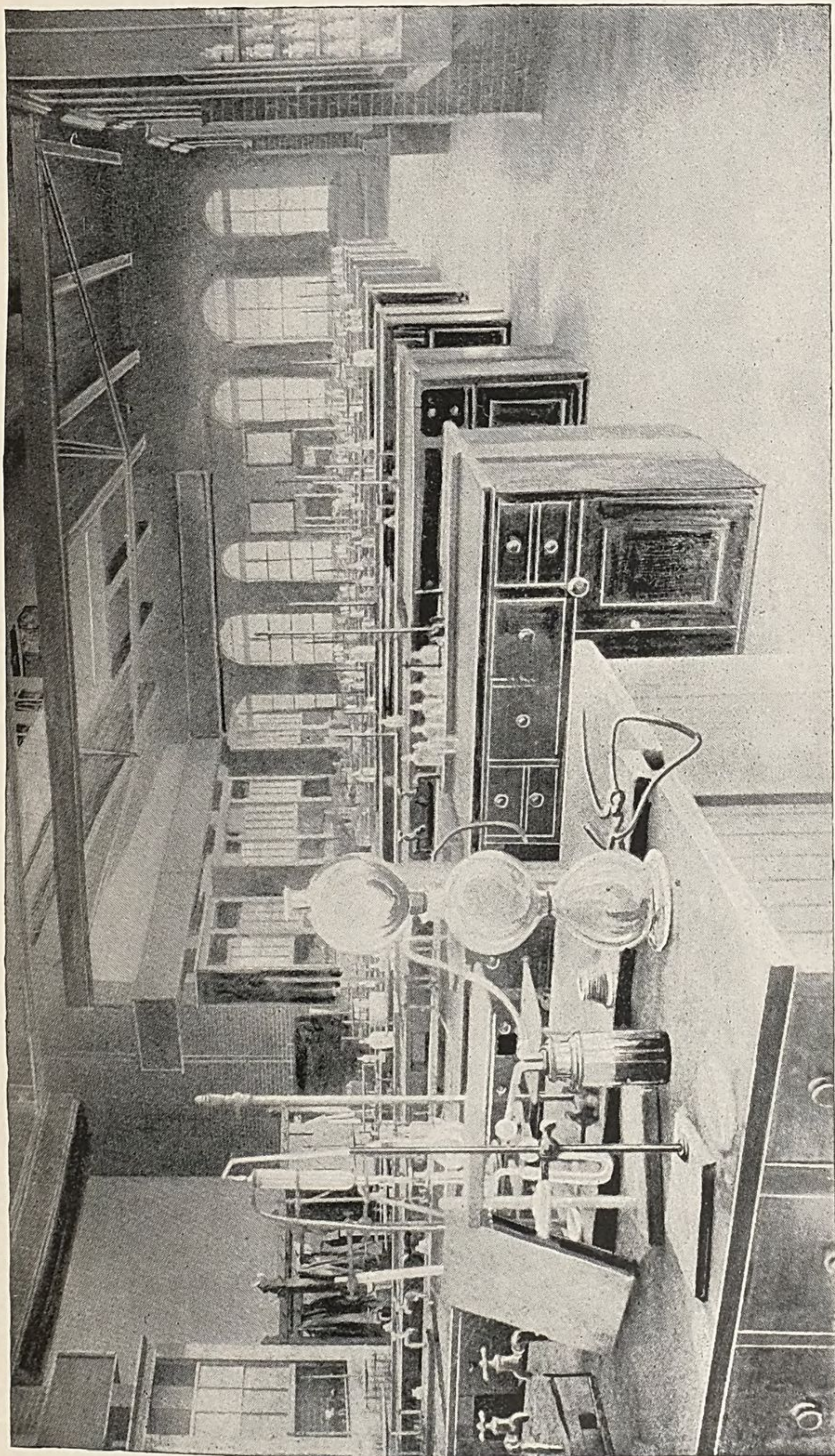


End Elevation.

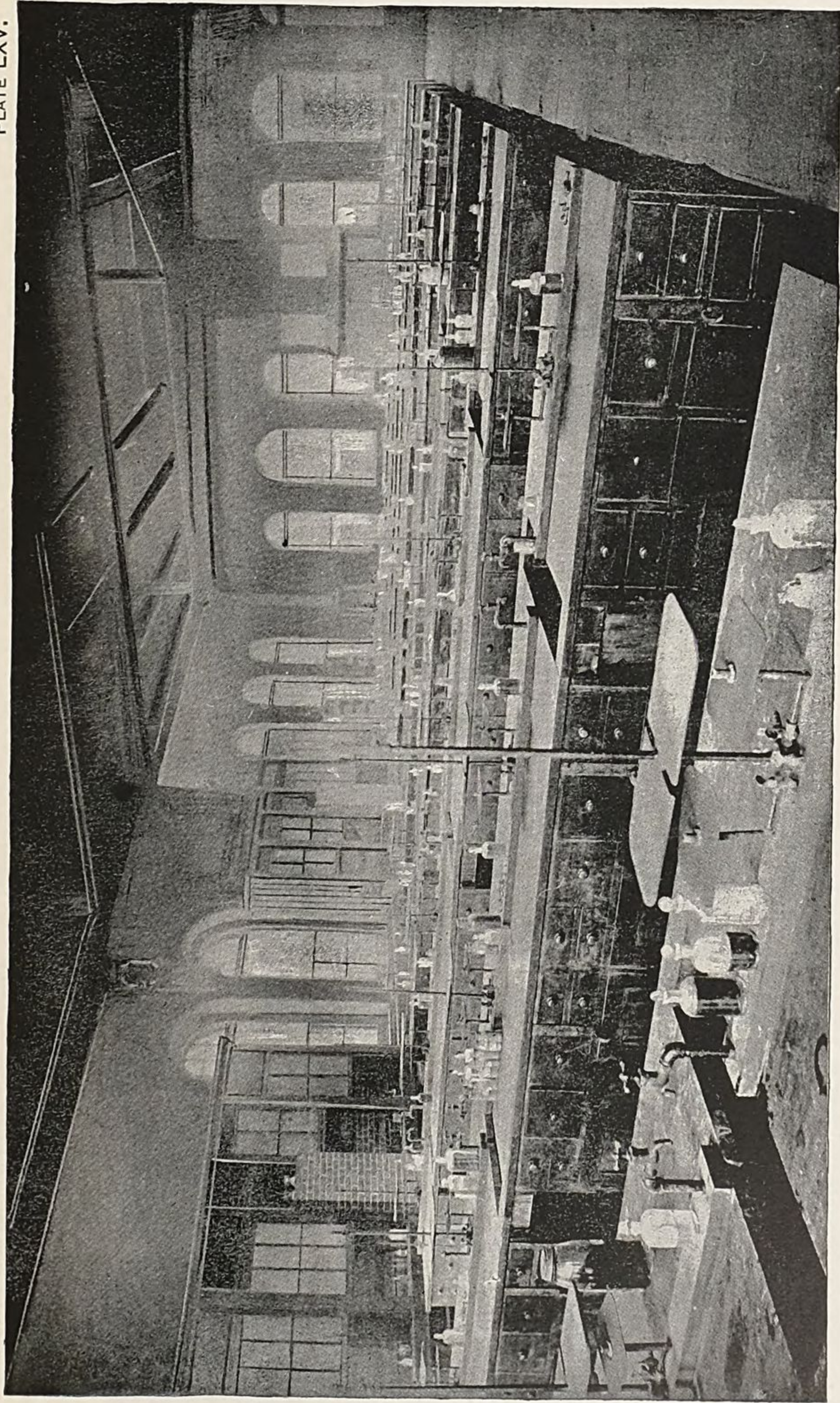


in. = 1 ft.

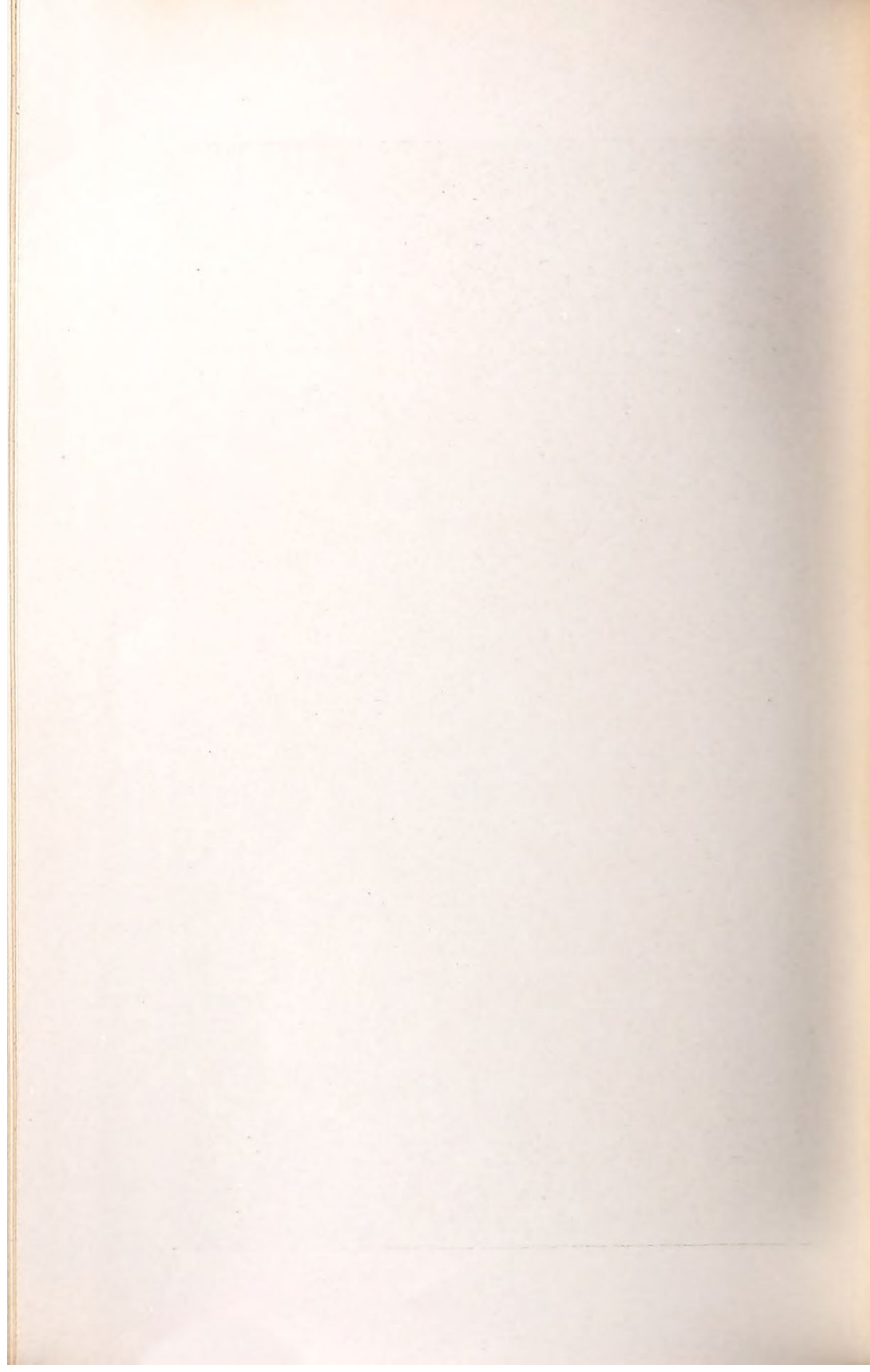
OF LABORATORY OF GENERAL CHEMISTRY.

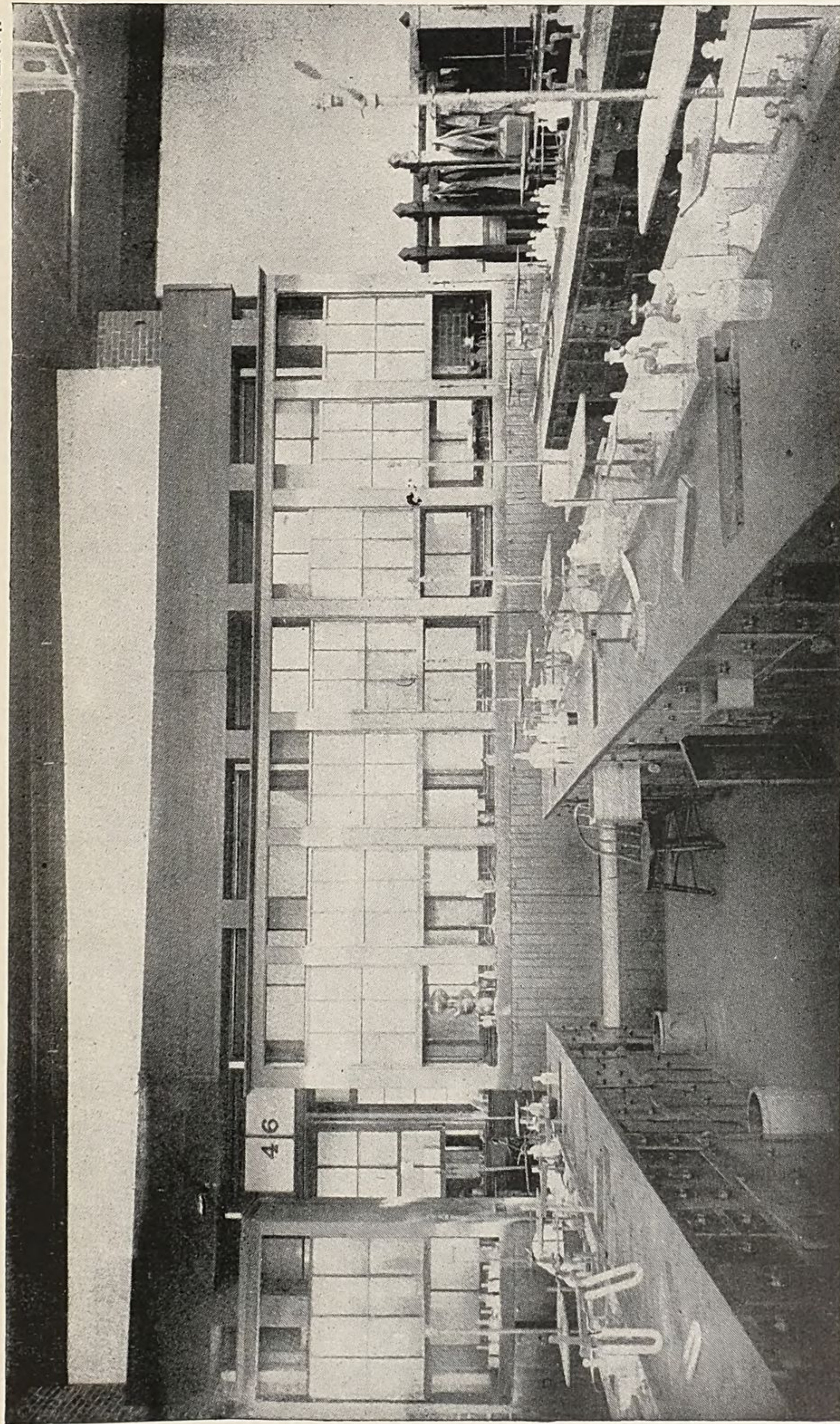


MASSACHUSETTS INSTITUTE OF TECHNOLOGY—LABORATORY OF ANALYTICAL CHEMISTRY.

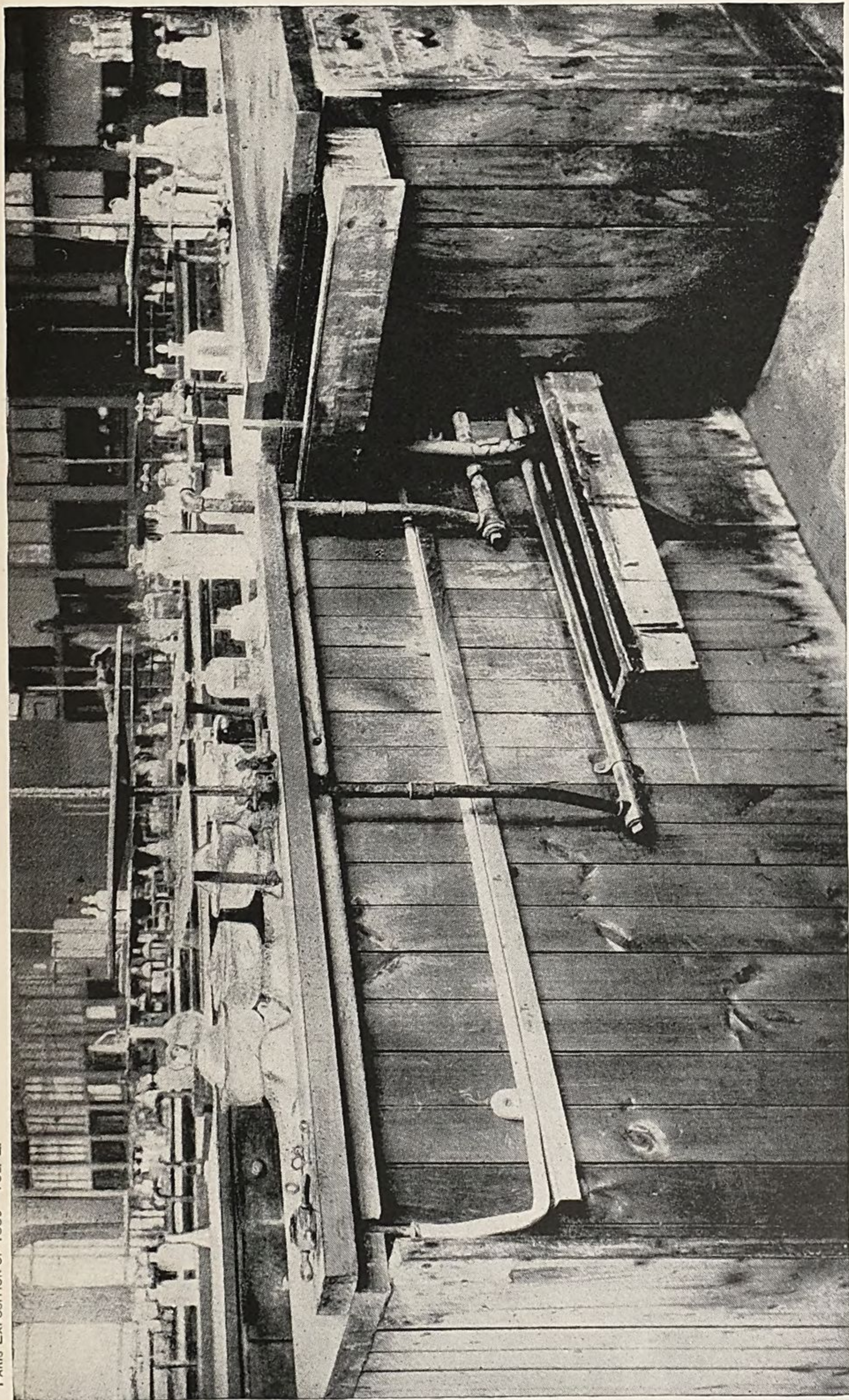


MASSACHUSETTS INSTITUTE OF TECHNOLOGY—LABORATORY OF ANALYTICAL CHEMISTRY.

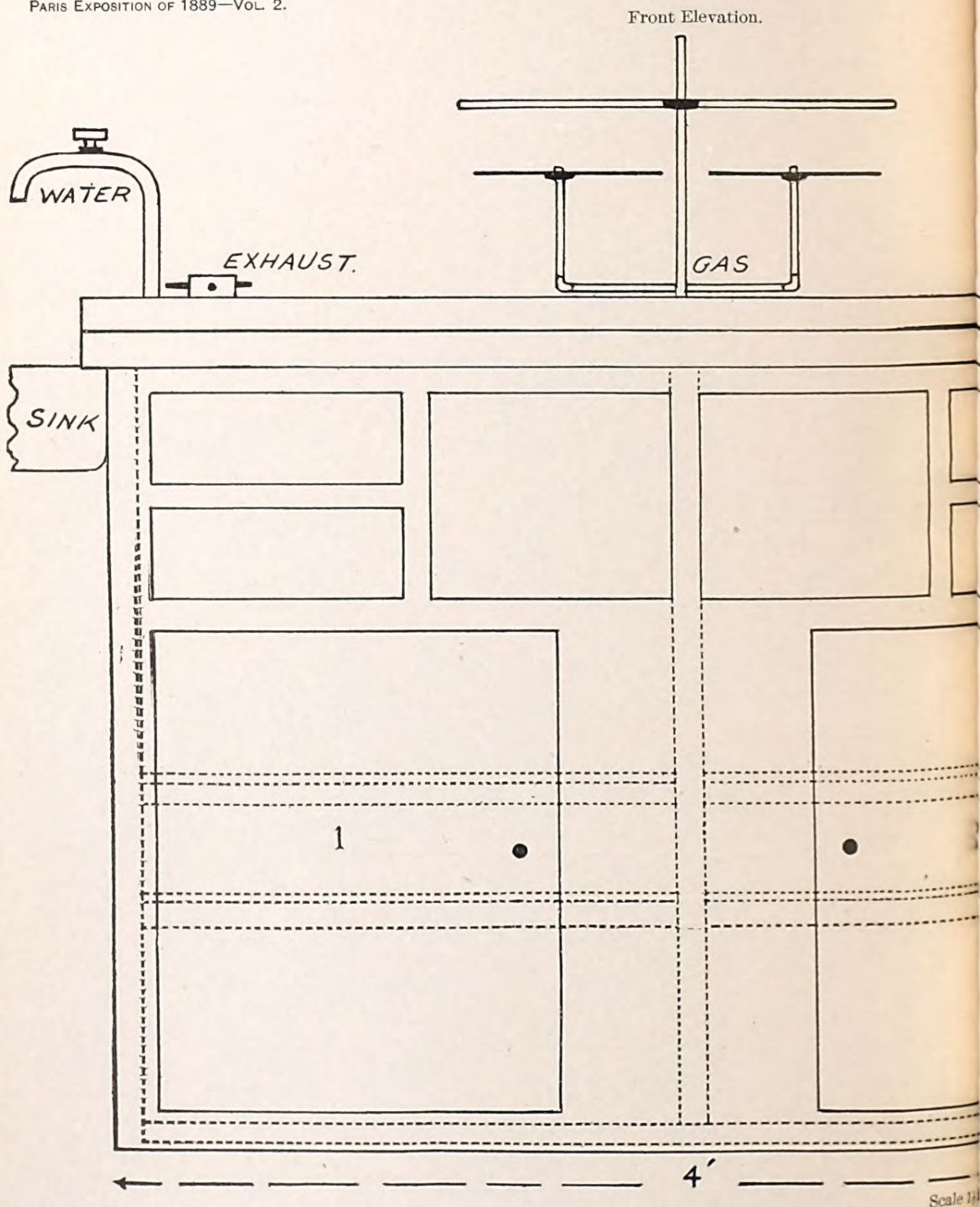




MASSACHUSETTS INSTITUTE OF TECHNOLOGY—LABORATORY OF ANALYTICAL CHEMISTRY.

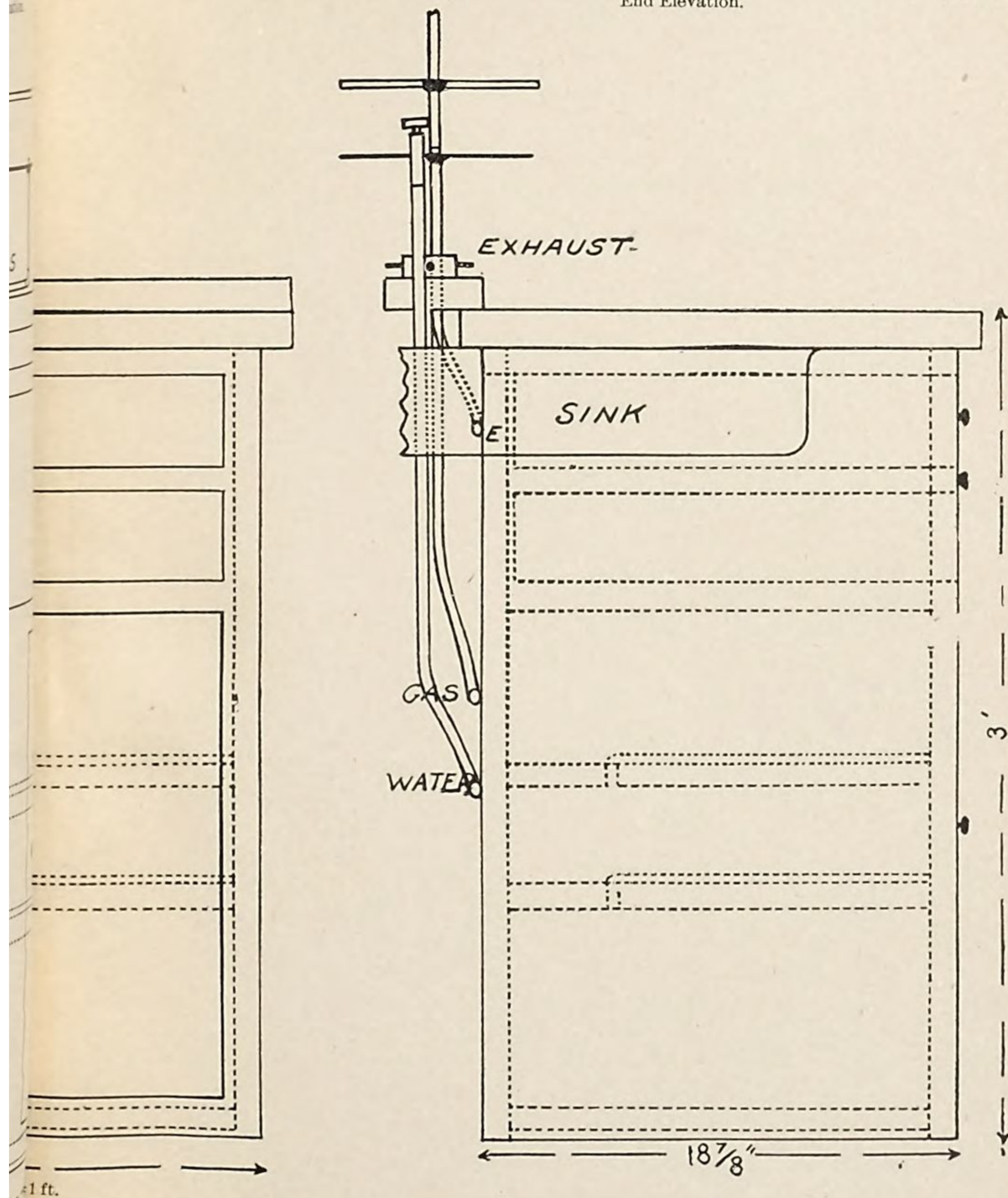


MASSACHUSETTS INSTITUTE OF TECHNOLOGY—LABORATORY OF ANALYTICAL CHEMISTRY.

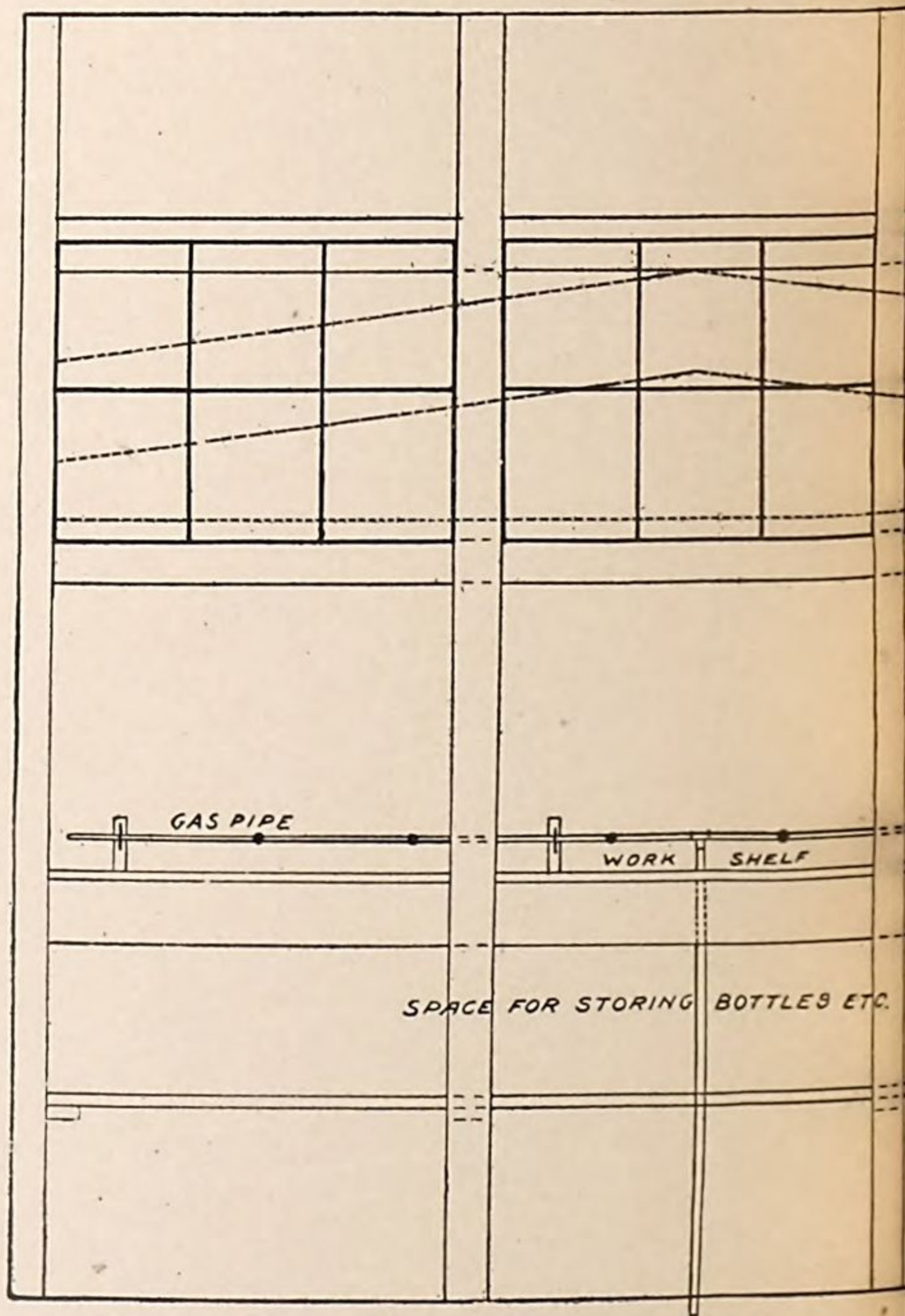


End Elevation.

PLATE LXVIII.



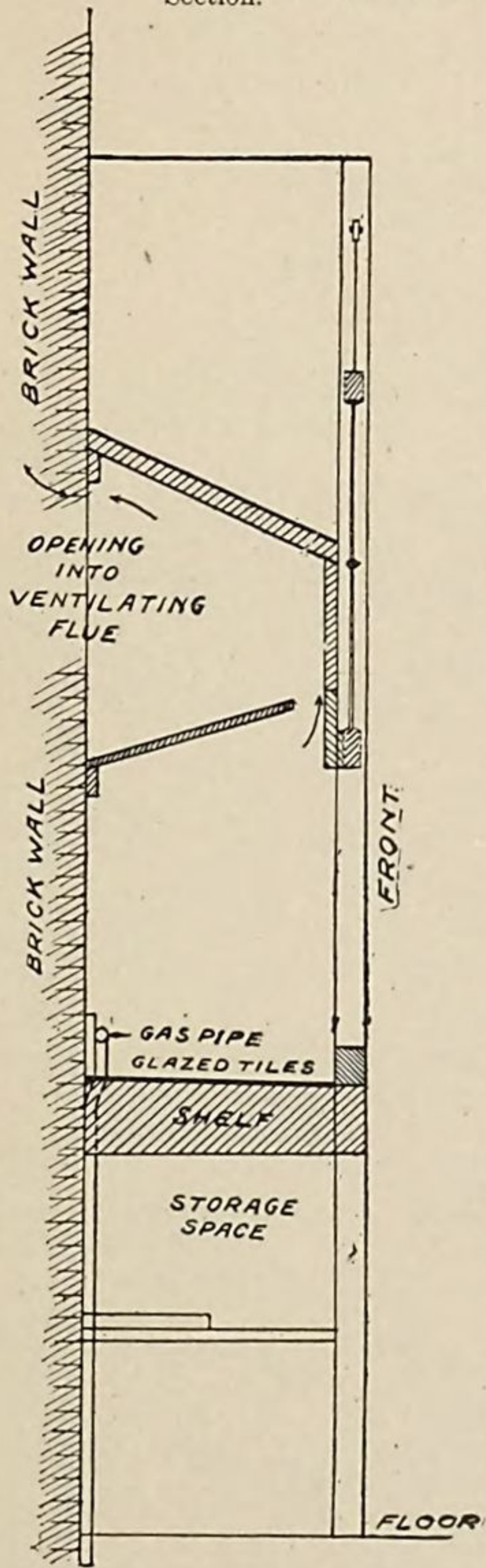
1 ft.
OF THE LABORATORY OF ANALYTICAL CHEMISTRY.



Scale: 1/4"

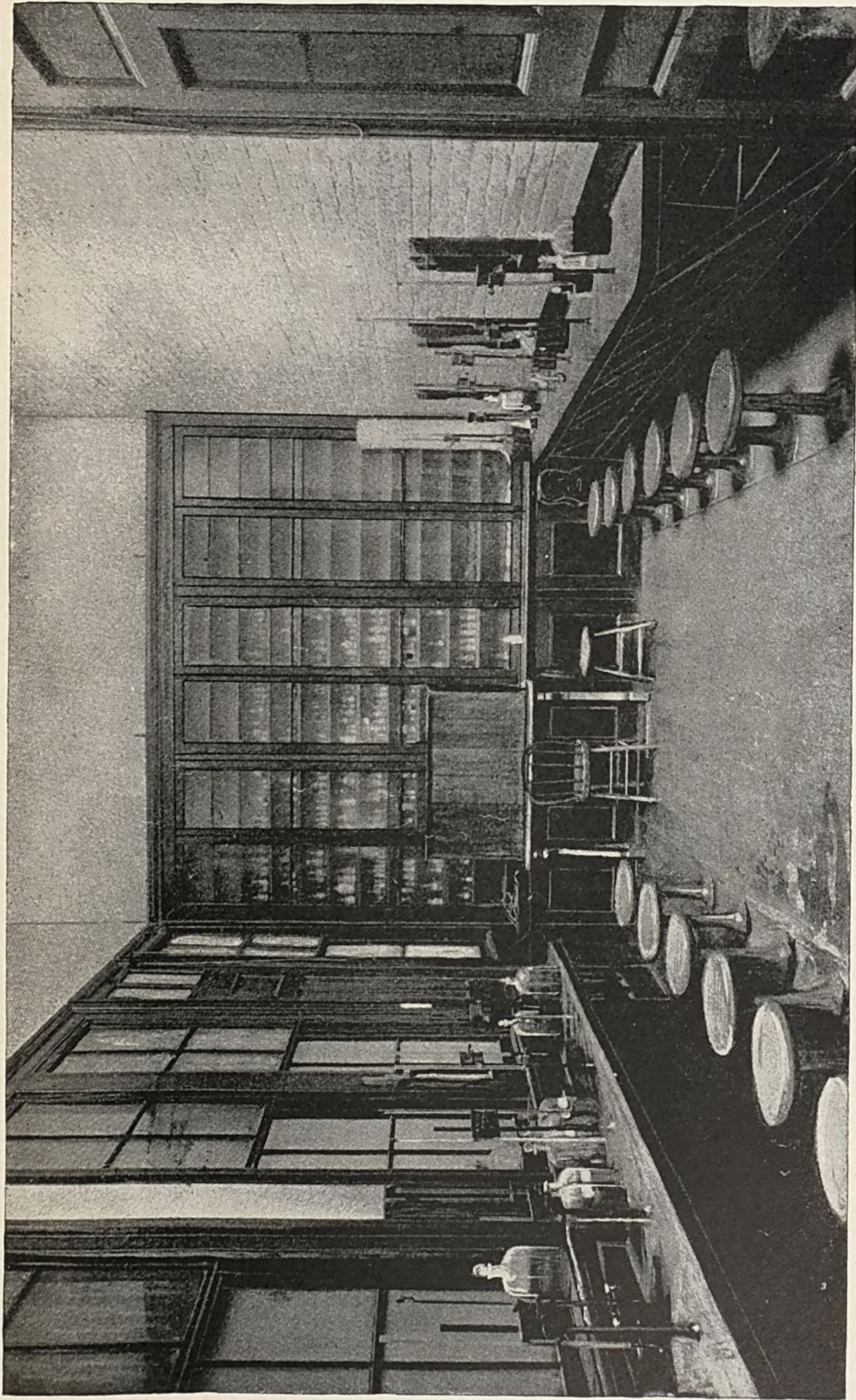
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Section. PLATE LXIX.

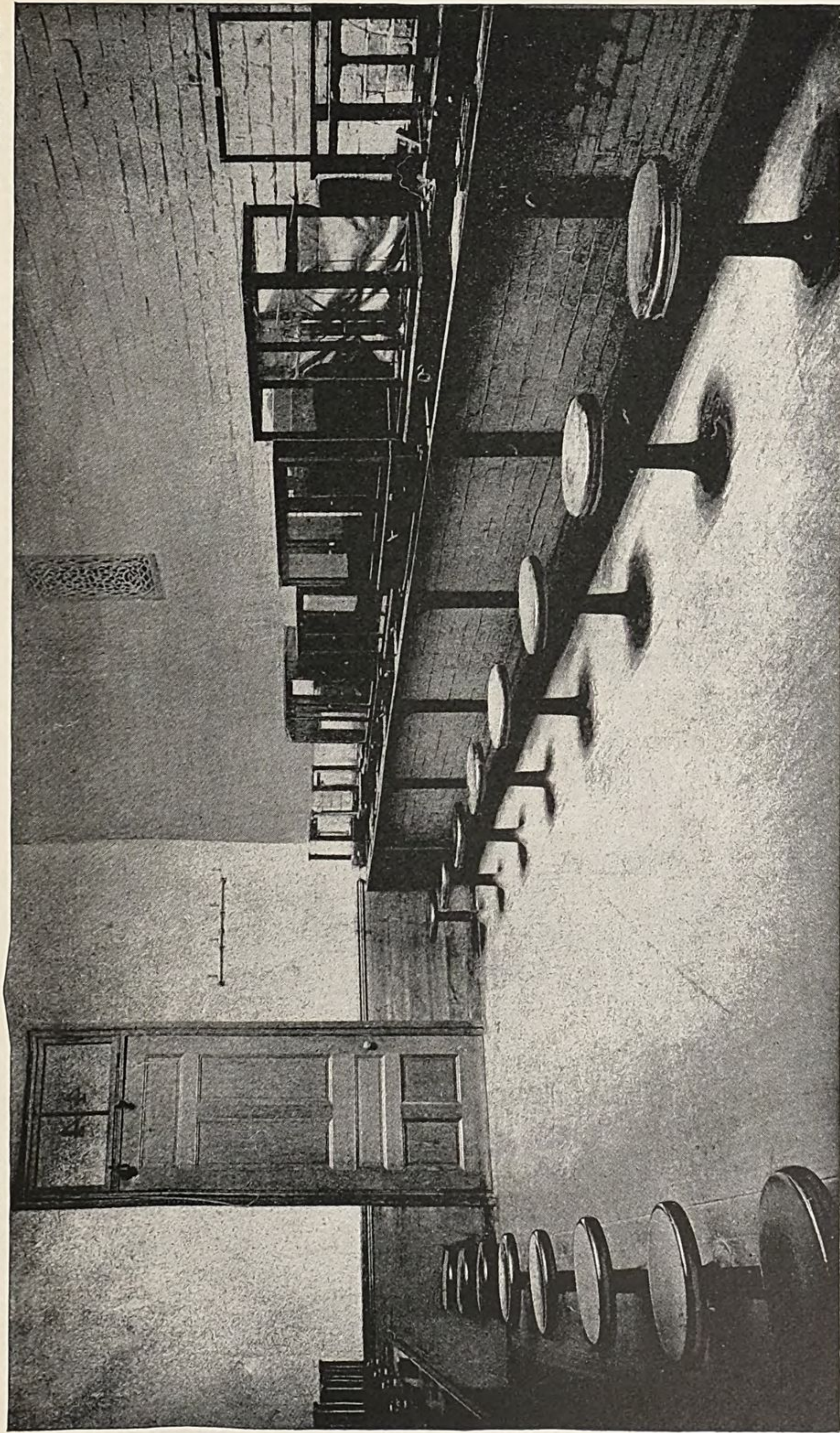


= 1 ft.

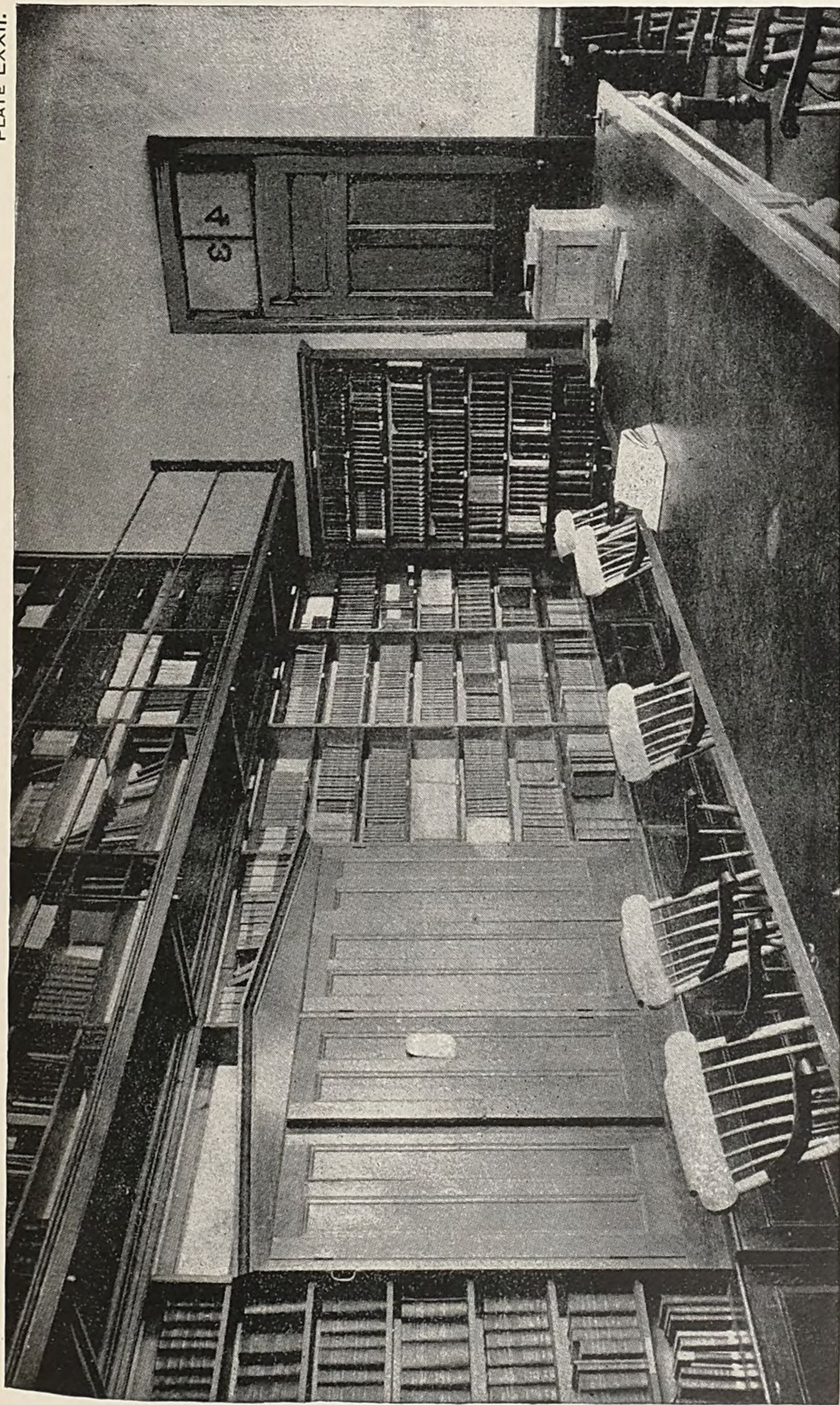
OF TECHNOLOGY—HOOD.



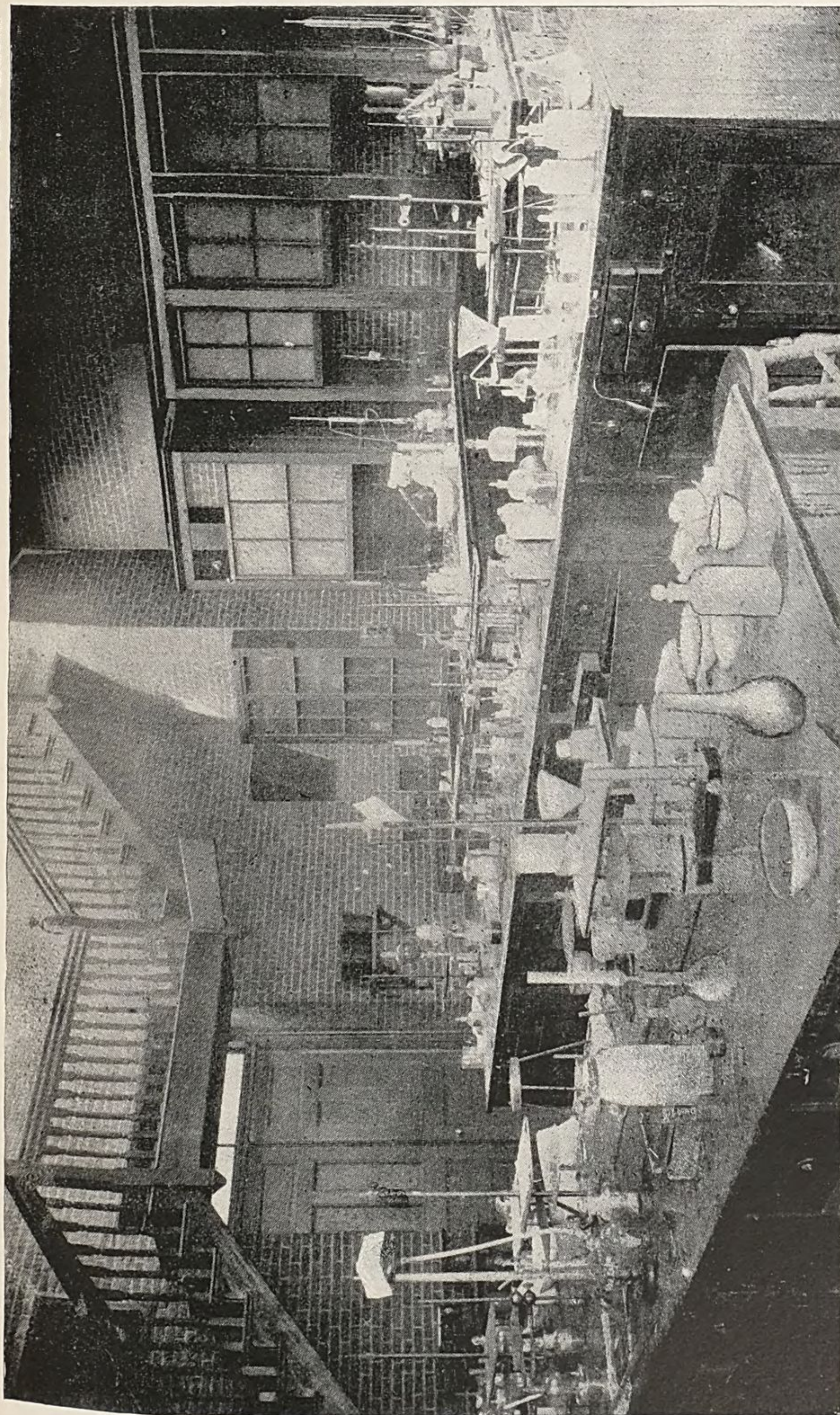
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—LABORATORY FOR VOLUMETRIC ANALYSIS.



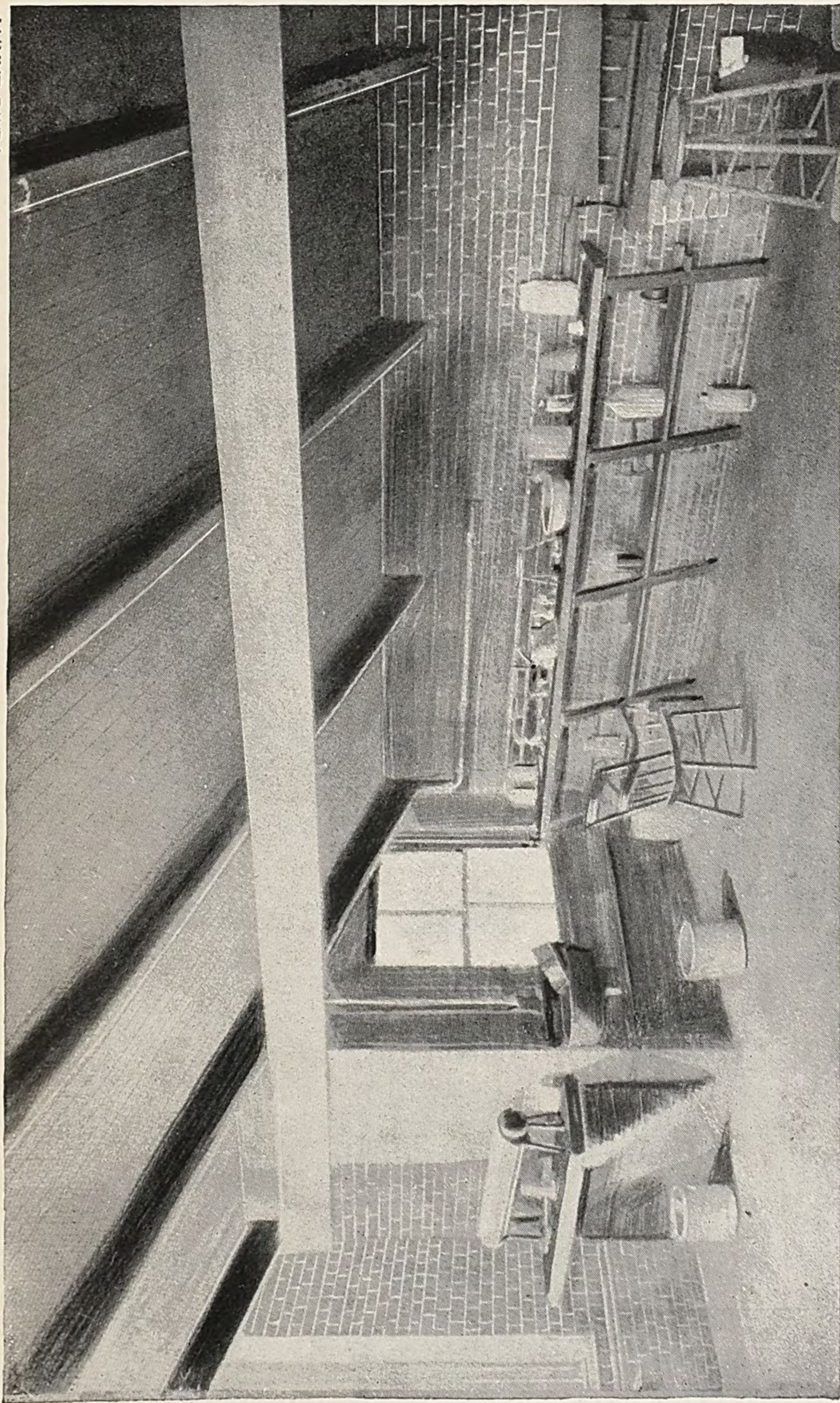
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—BALANCE ROOM.



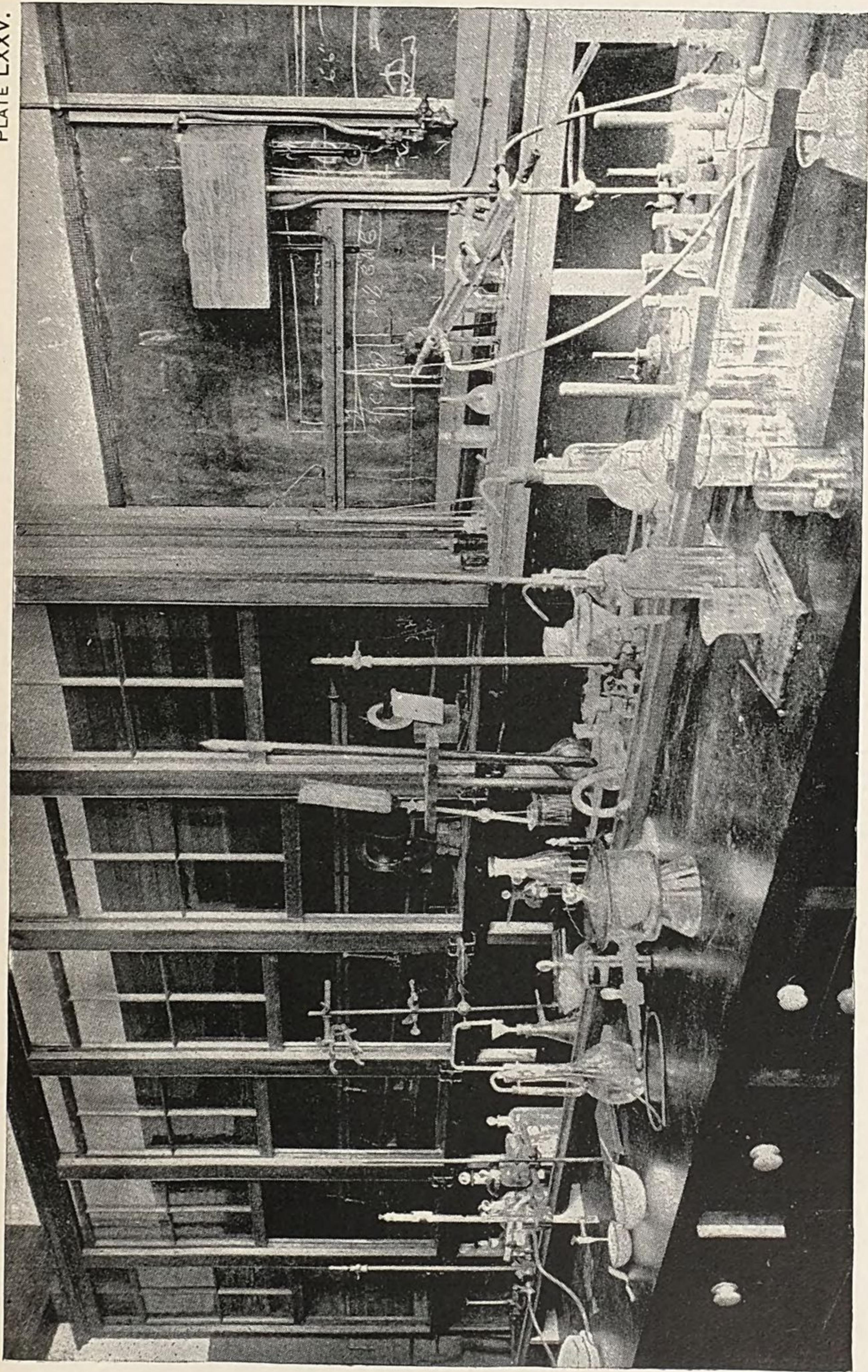
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—CHEMICAL LIBRARY AND READING ROOM.



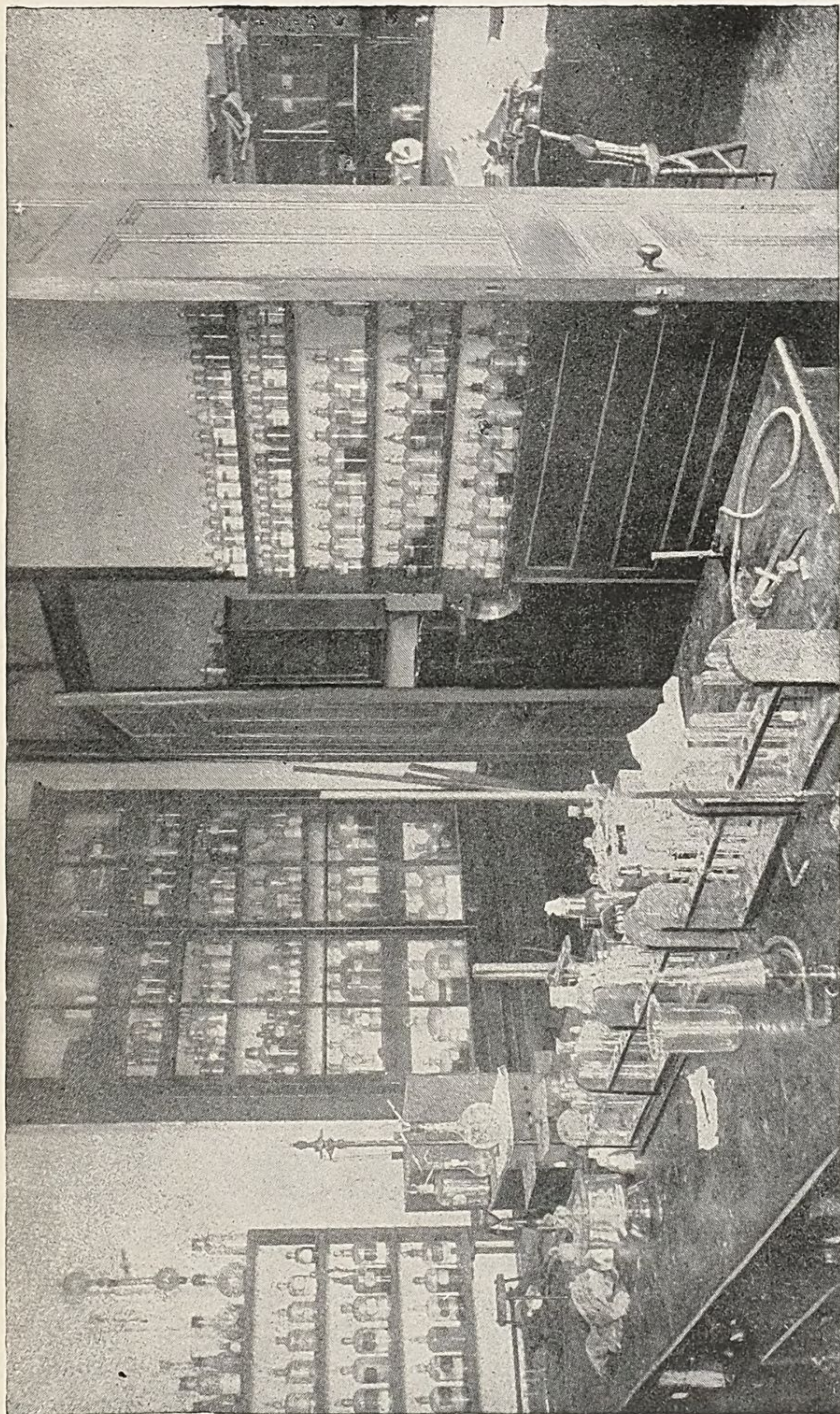
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—GENERAL ORGANIC LABORATORY.



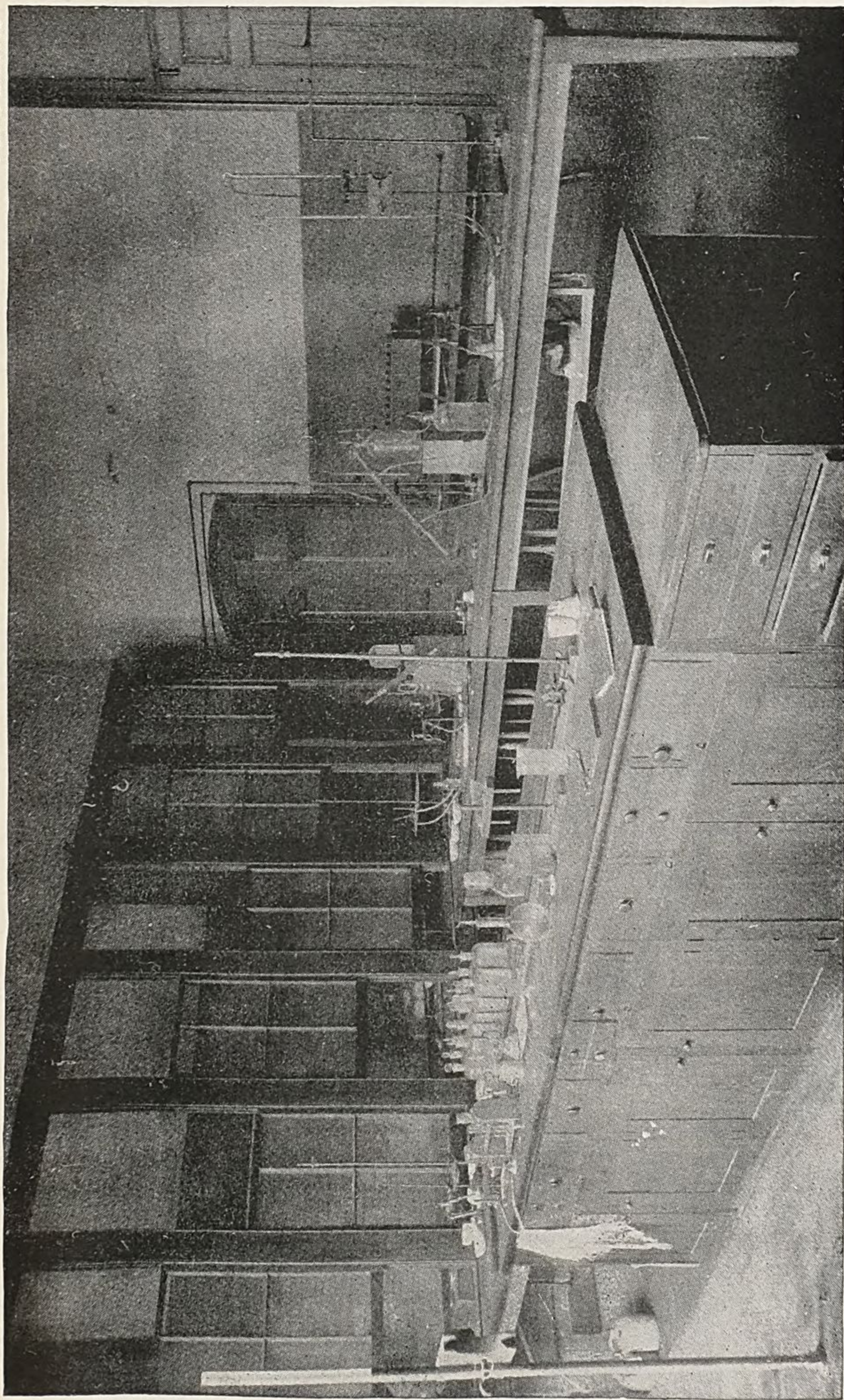
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—ORGANIC FURNACE ROOM.



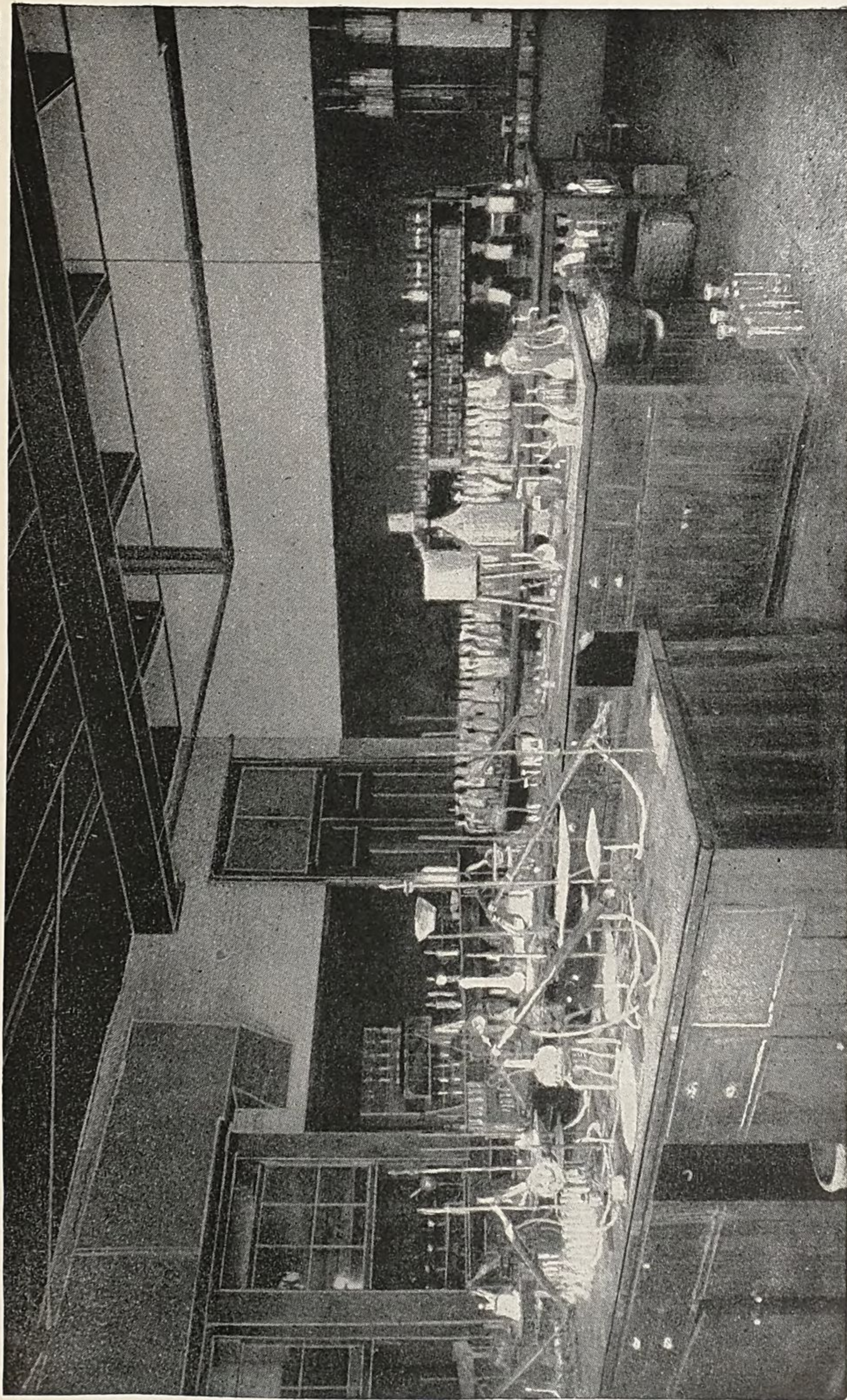
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—ORGANIC LABORATORY FOR RESEARCH.



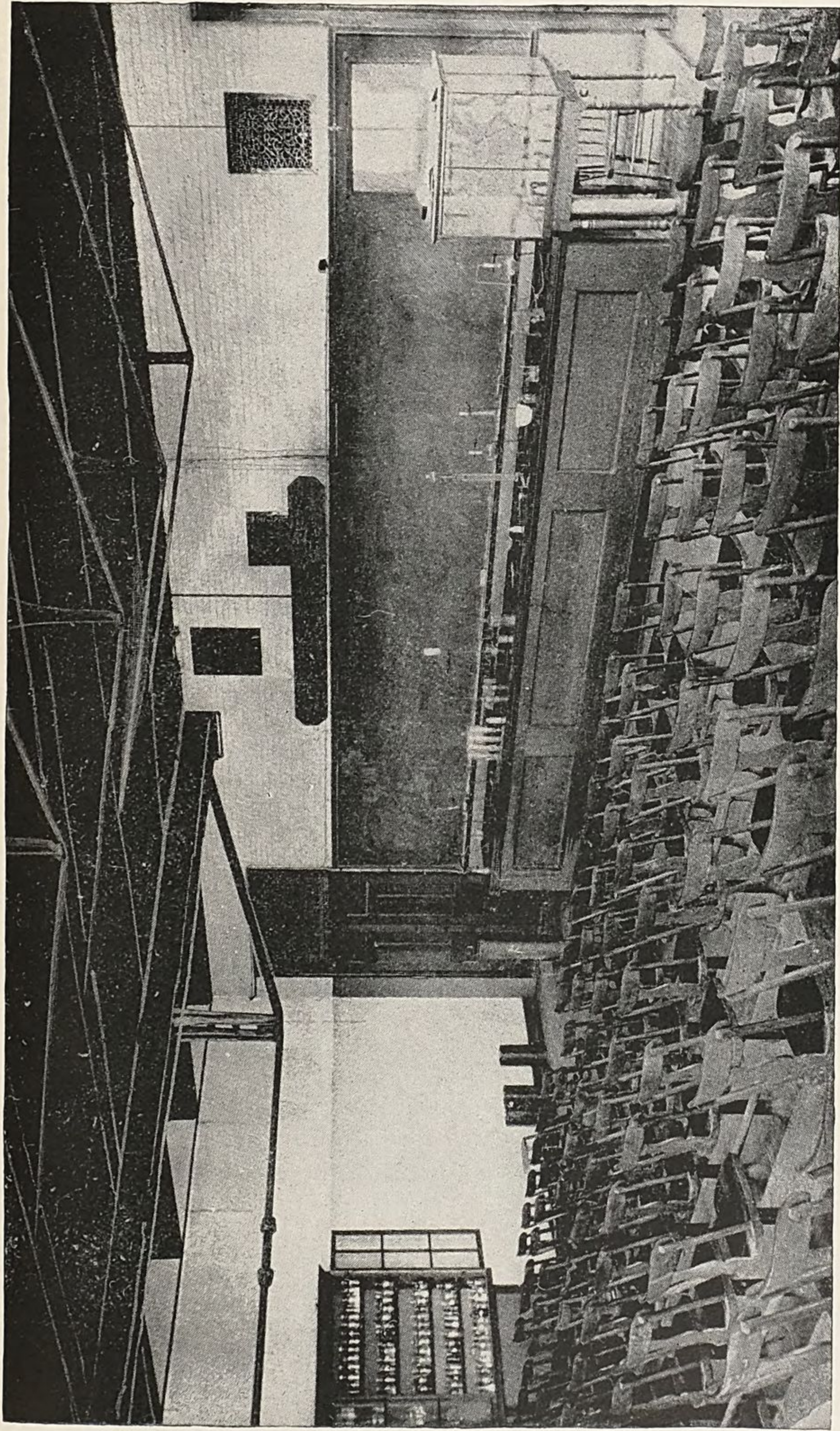
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—PRIVATE LABORATORY.



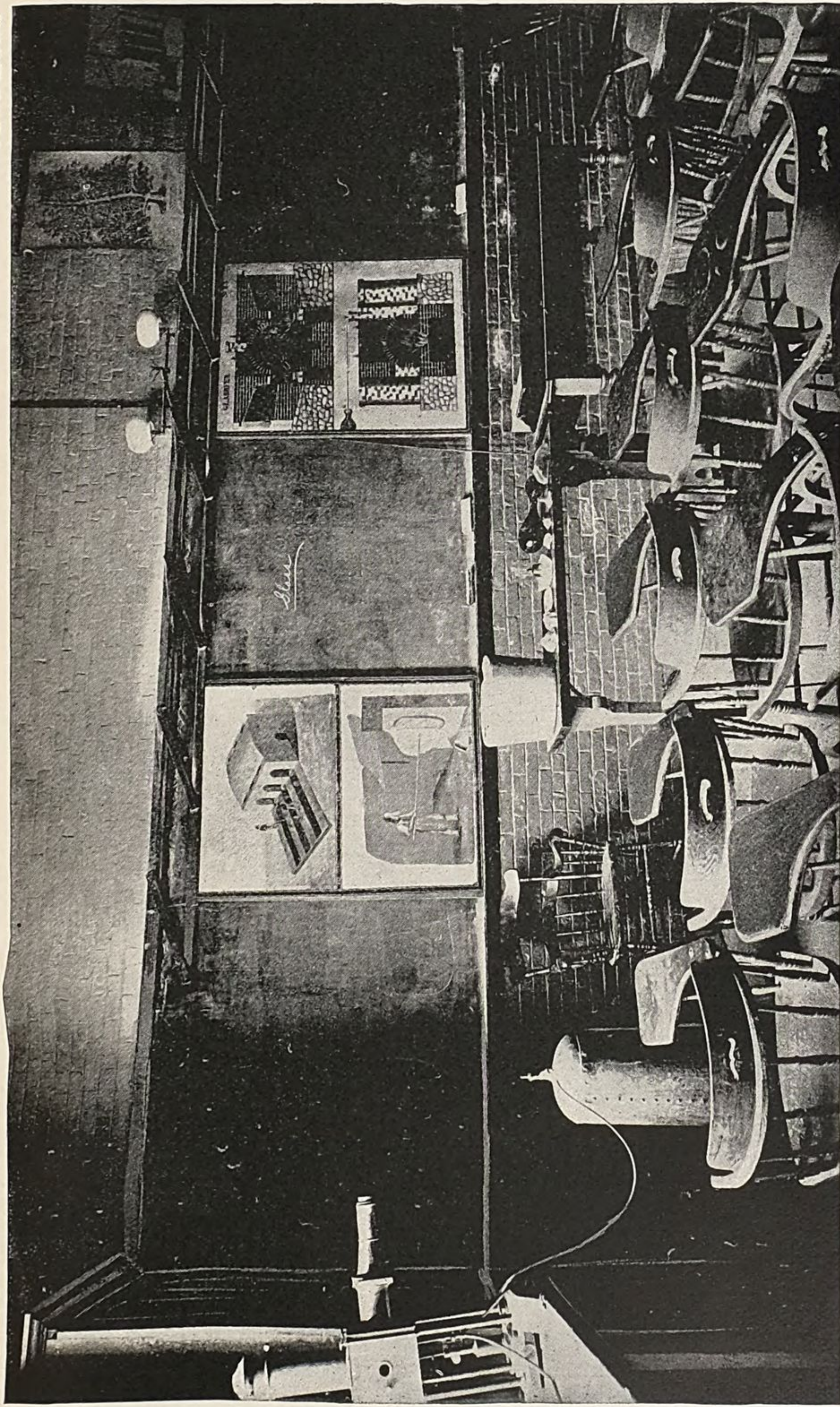
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—LABORATORY OF SANITARY CHEMISTRY.



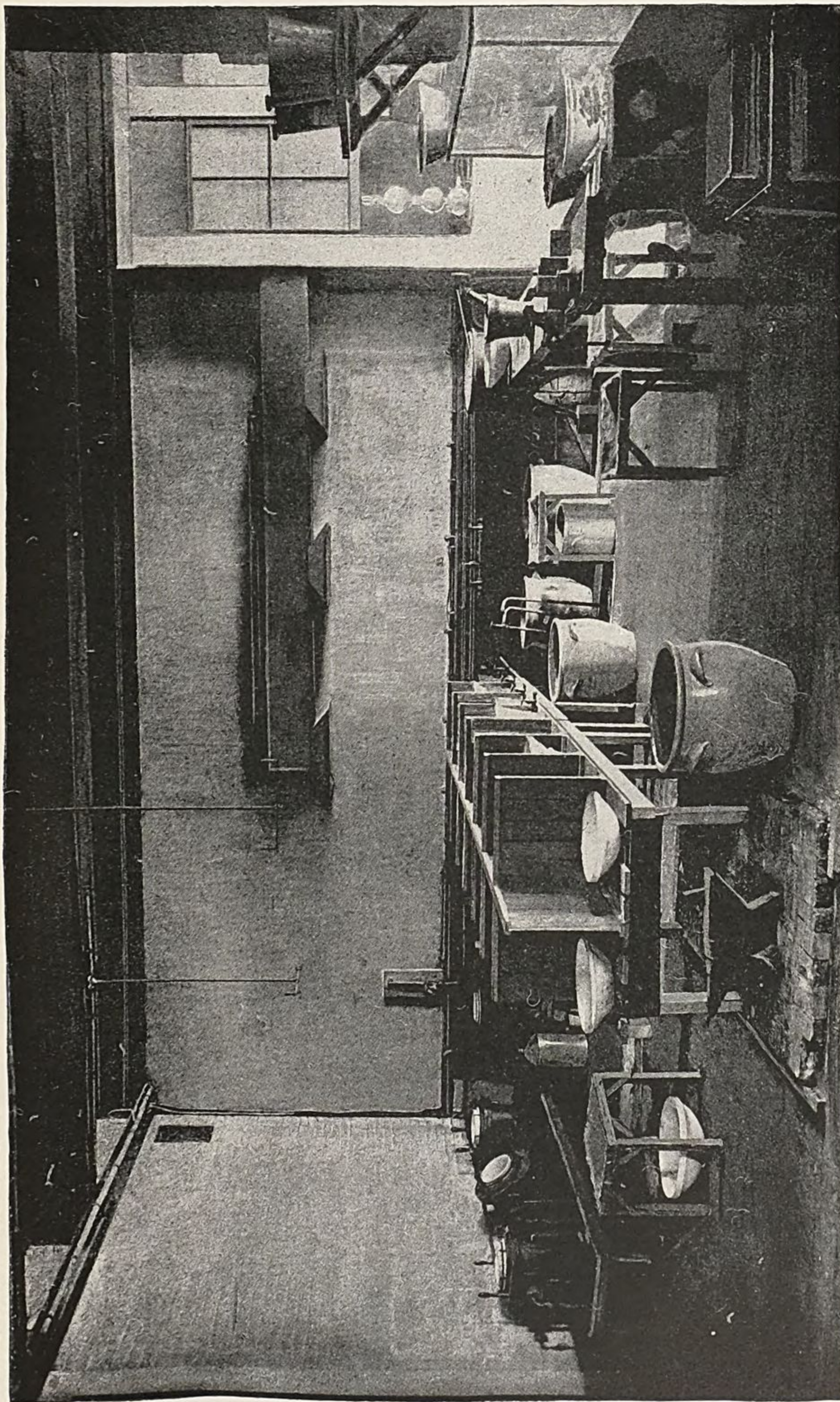
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—LABORATORY FOR WATER AND GAS ANALYSIS.



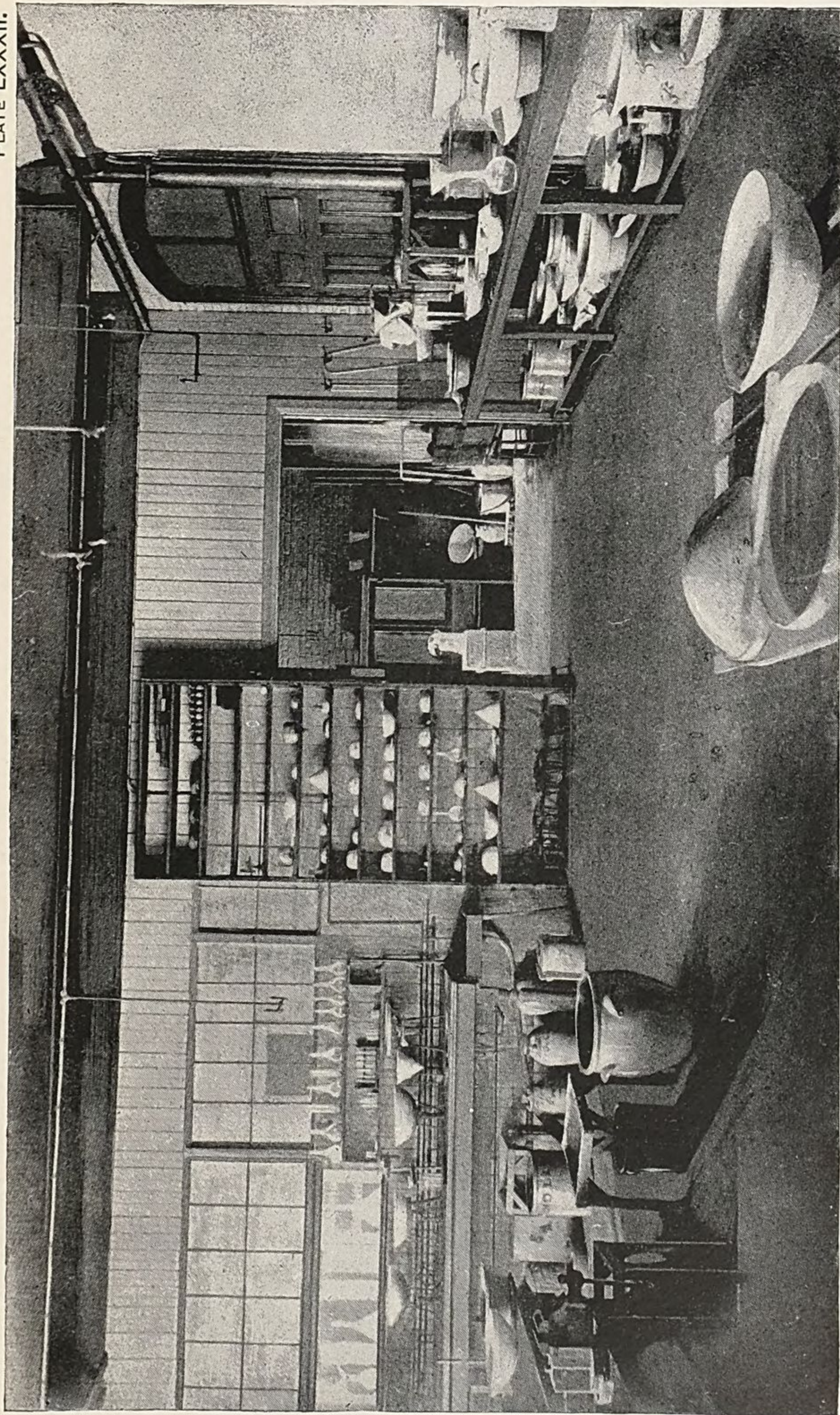
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—CHEMICAL LECTURE ROOM.



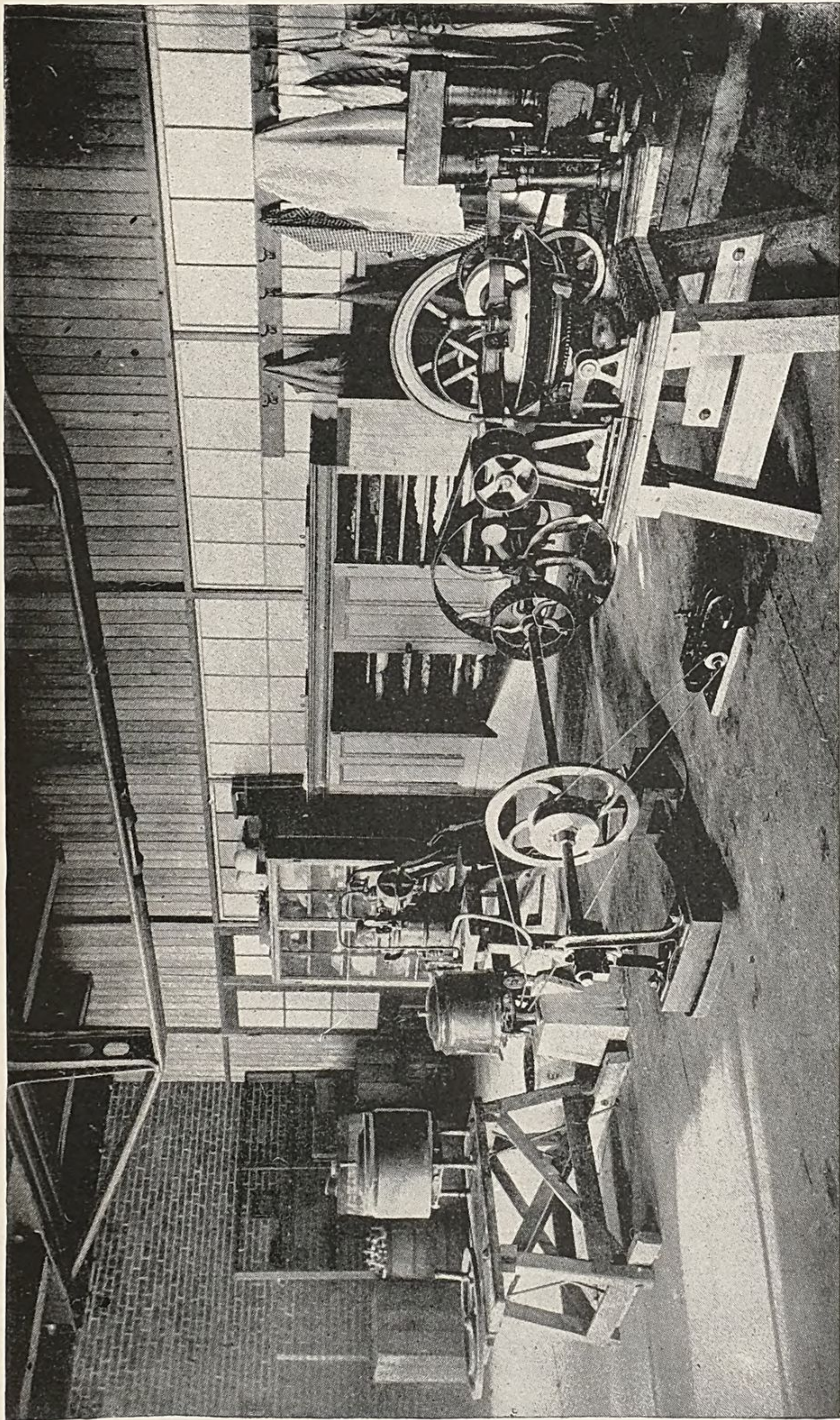
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—SMALLER CHEMICAL LECTURE ROOM.



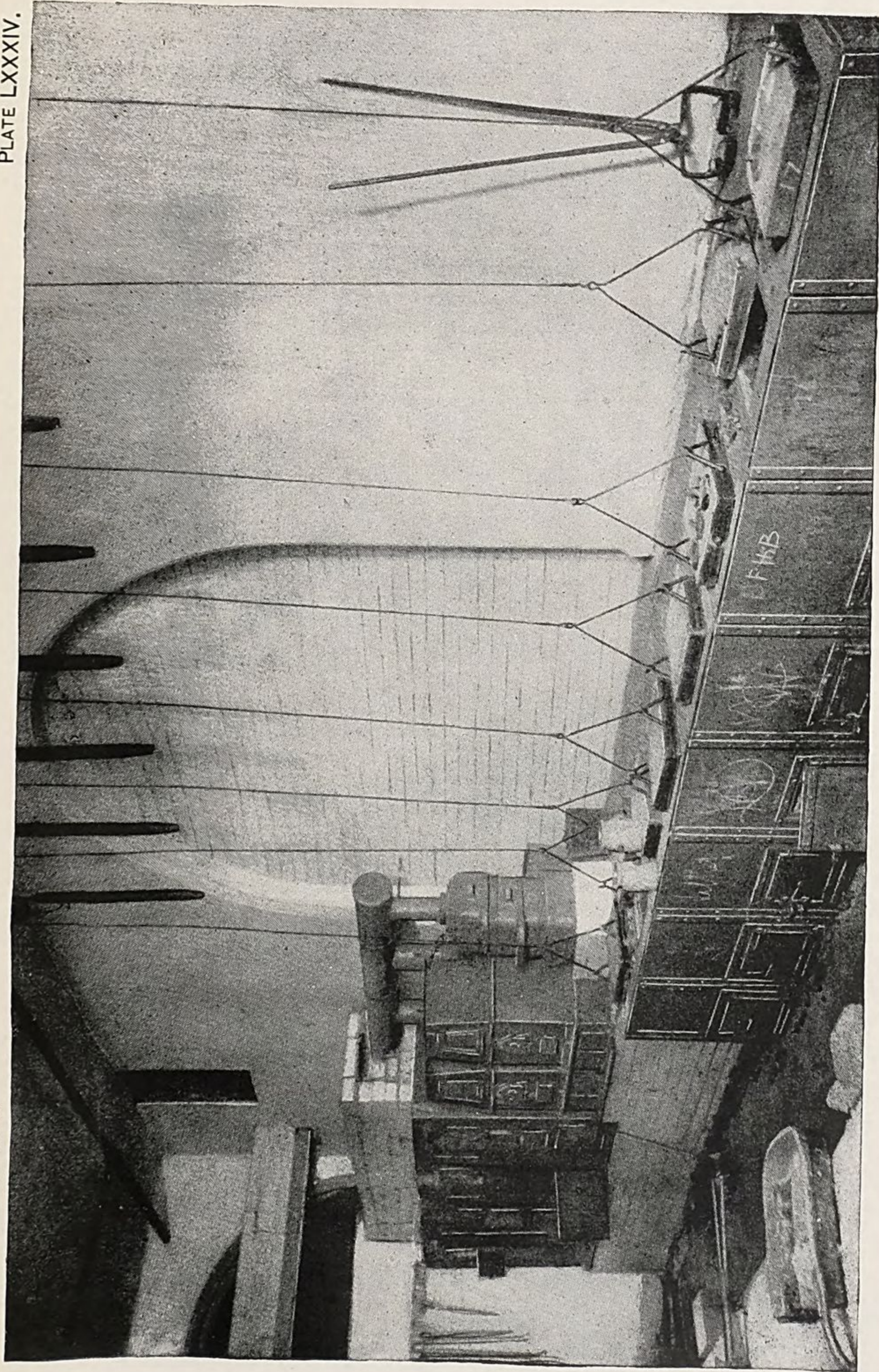
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—LABORATORY OF INDUSTRIAL CHEMISTRY.



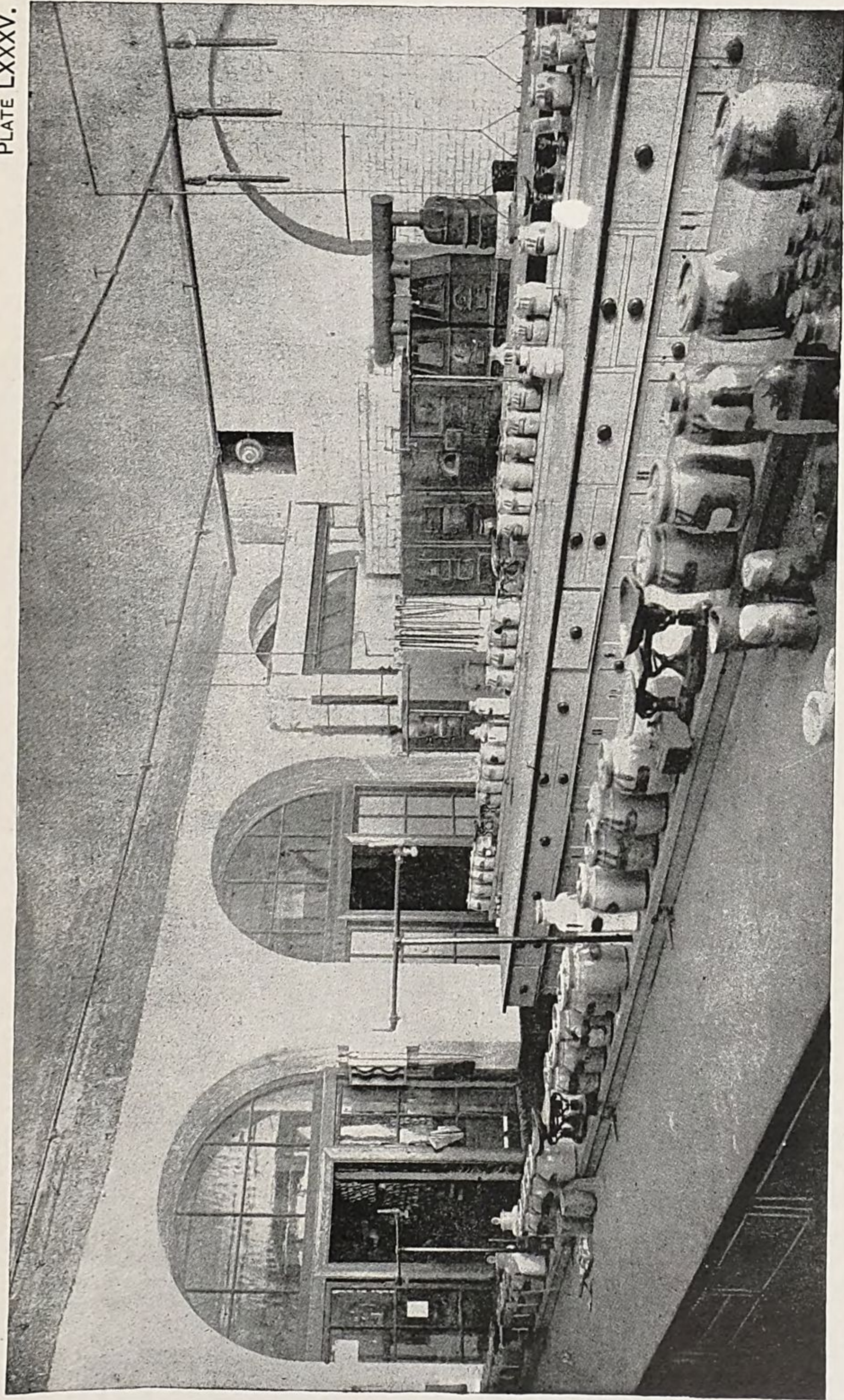
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—LABORATORY OF INDUSTRIAL CHEMISTRY.



MASSACHUSETTS INSTITUTE OF TECHNOLOGY—LABORATORY OF INDUSTRIAL CHEMISTRY.



MASSACHUSETTS INSTITUTE OF TECHNOLOGY—ASSAY LABORATORY.



MASSACHUSETTS INSTITUTE OF TECHNOLOGY—ASSAY LABORATORY.

THE NEW YORK PUBLIC LIBRARY

THE CHEMICAL LABORATORIES OF CORNELL UNIVERSITY,
ITHACA, NEW YORK, ERECTED 1890.

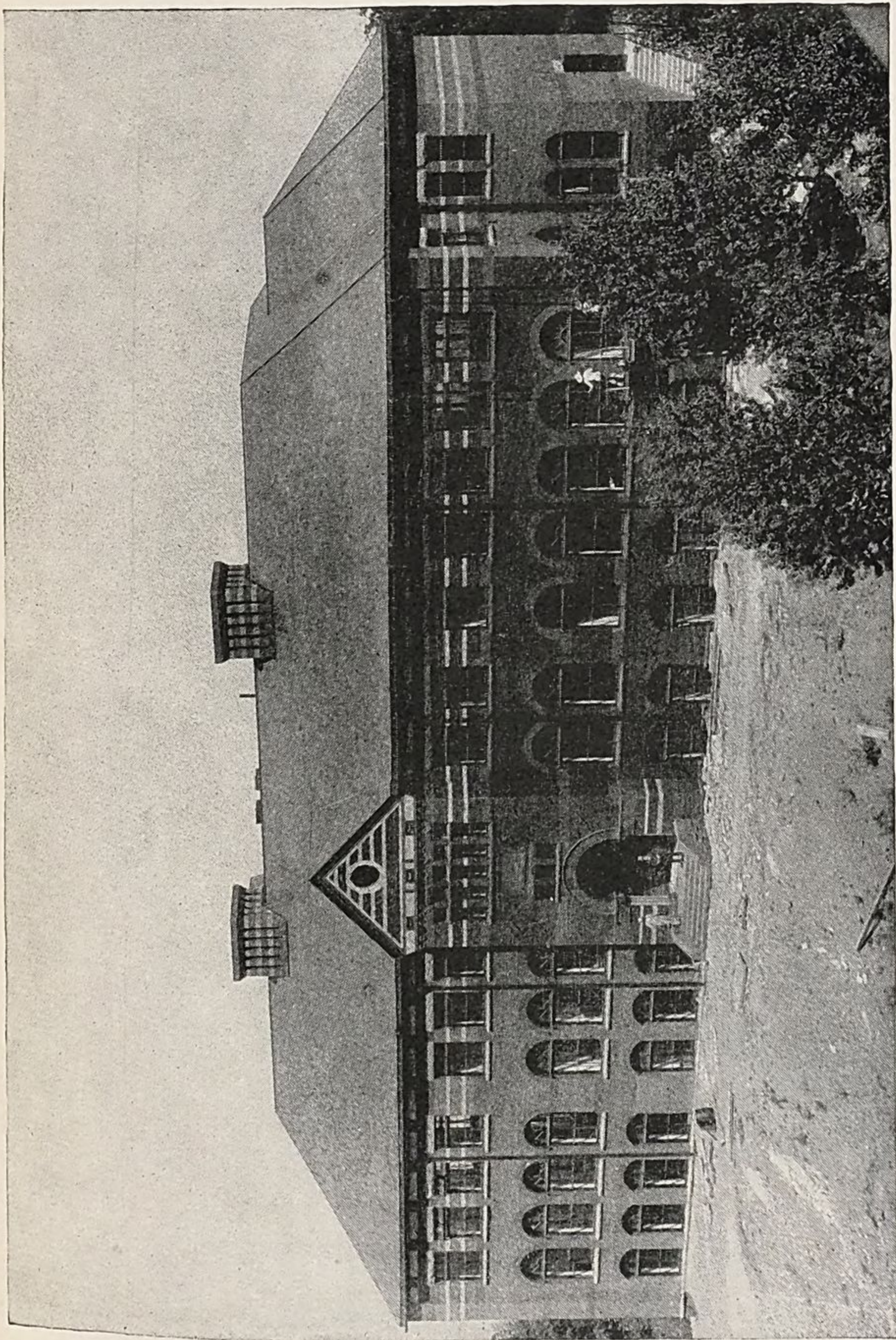
(With 4 plates.)

The building is 180 feet long by 50 and 70 feet wide, and consists of two stories and a basement. It is built of red brick and has a roof of red slate. It is built throughout on the principles of "slow burning" or "mill" construction, all floors being made of solid planks with $1\frac{1}{2}$ inches of cement in which the flooring is laid, and all beams exposed. The students' laboratories are three in number, one over the other on three floors, in the west end of the building. These laboratories are for introductory practice, qualitative analysis, and quantitative analysis, respectively; they are 45 by 70 feet in size, and have on the average about 80 tables each. The organic laboratory in the basement is provided with twenty-four places. Several special and private laboratories are provided on each floor. The main lecture room, on the second floor, at the east end of the building, is 50 by 70 feet in size, and contains three hundred and fifty-two permanent seats with arm rests for taking notes. This room is provided with a special staircase for entrance of classes. Adjoining the lecture room are preparation rooms, private laboratory, etc., and the chemical museum, a large hall in which the museum of applied chemistry is displayed.

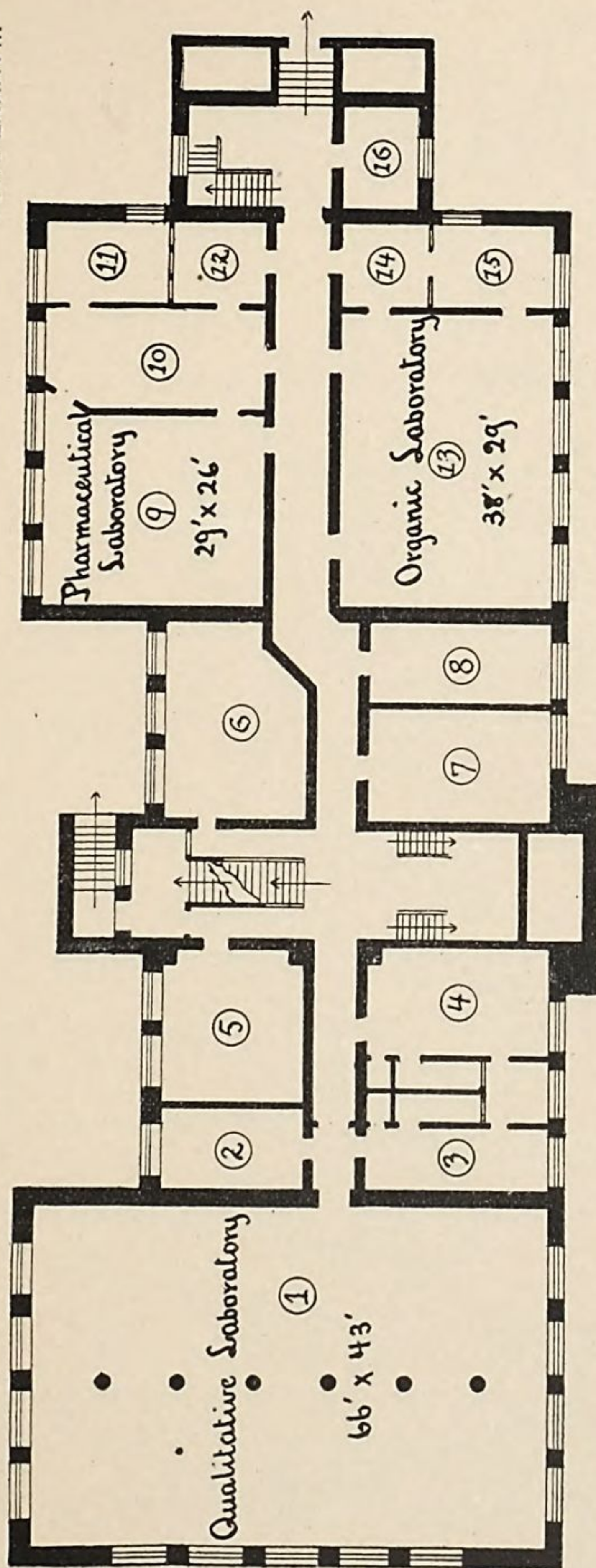
The building was originally designed for forced draft; the air to be blown into the rooms by a fan and making its exit through the hoods. Owing to the cost of a separate steam engine for this purpose this plan was abandoned, and influx of air secured by steam coils placed in the inlet flues. As the flues are all placed in two heavy flue walls which divide the building transversely and are thus always kept warm, it is found that natural draft is practically sufficient to secure good ventilation. Gas, water, vacuum, and blast are piped to all parts of the building, while oxygen and hydrogen, obtained by electrolysis of water by means of a large dynamo and water power, are supplied to the chief laboratories and the two lecture rooms. The building is capable of accommodating nearly four hundred students, working at one time, in its several laboratories. The cost of the building, including plumbing, was about \$60,000; the necessary furniture and other fixtures amounted to nearly \$20,000, making the total cost of building and equipment about \$80,000. The laboratory was opened for admission of students on the 1st of October, 1890.

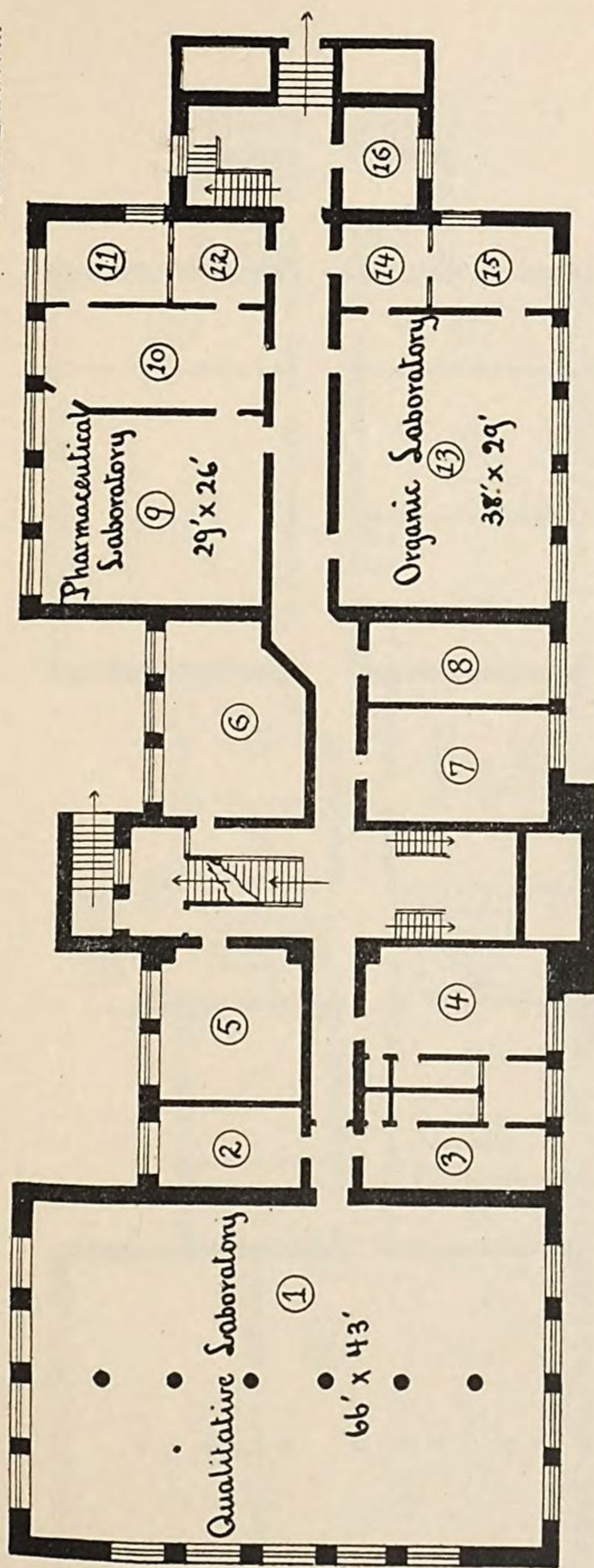
- | | |
|--|-------------------------------------|
| 1. Qualitative laboratory. | 6. Lavatory and closets. |
| 2, 3. Instructors' rooms. | 7. Special laboratory. |
| 4. Agricultural experiment laboratory. | 8. Combustion room. |
| 5. Storeroom. | 9, 10. Pharmaceutical laboratories. |

- | | |
|------------------------------|--|
| 11. Professor's office. | 24. Library. |
| 12. Storeroom. | 25. Small lecture room. |
| 13. Organic laboratory. | 26, 27, 28. Special analytical laboratories. |
| 14. Storeroom. | 29. Men's coatroom. |
| 15. Professor's office. | 30. Introductory laboratory. |
| 16. Photographic room. | 31. Instructor's room. |
| 17. Quantitative laboratory. | 32. Special laboratory. |
| 18. Instructor's room. | 33. Chemical museum. |
| 19. Storeroom. | 34. Curator's room. |
| 20. Instructor's room. | 35. Preparation room. |
| 21. Professor's laboratory. | 36. Professor's office. |
| 22. Women's cloakroom. | 37. Professor's laboratory. |
| 23. Combustion room. | 38. Lecture room. |

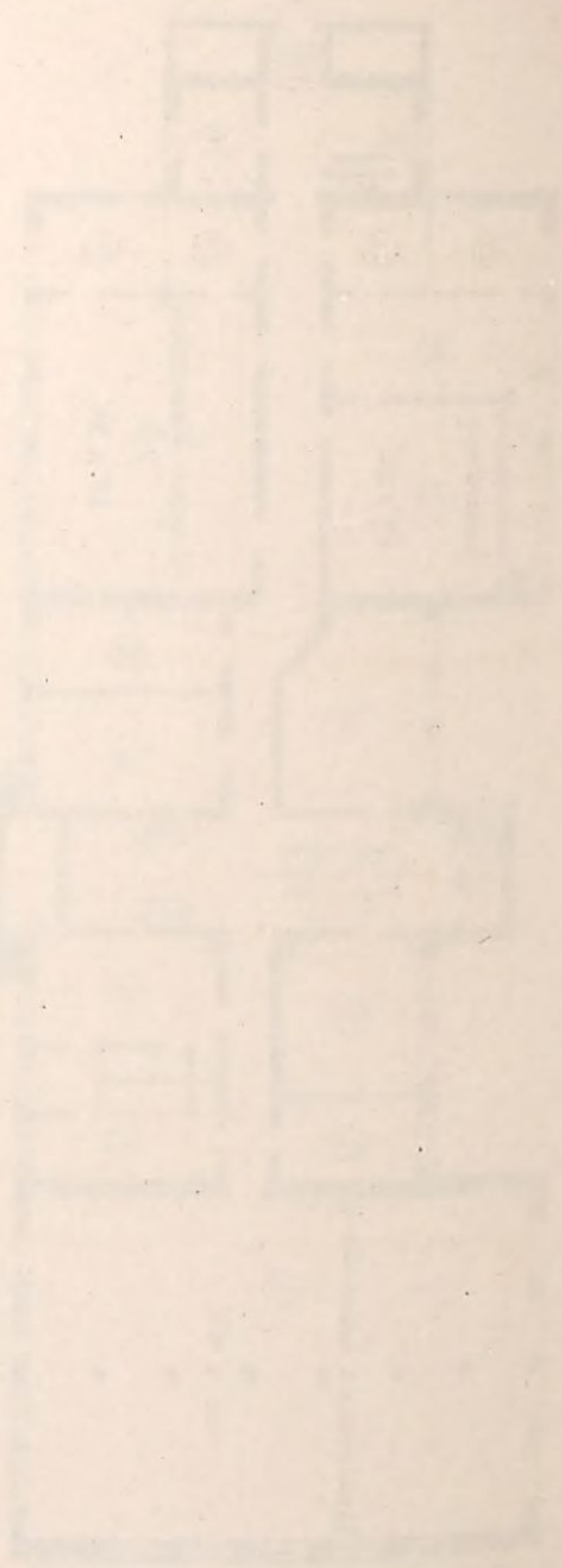


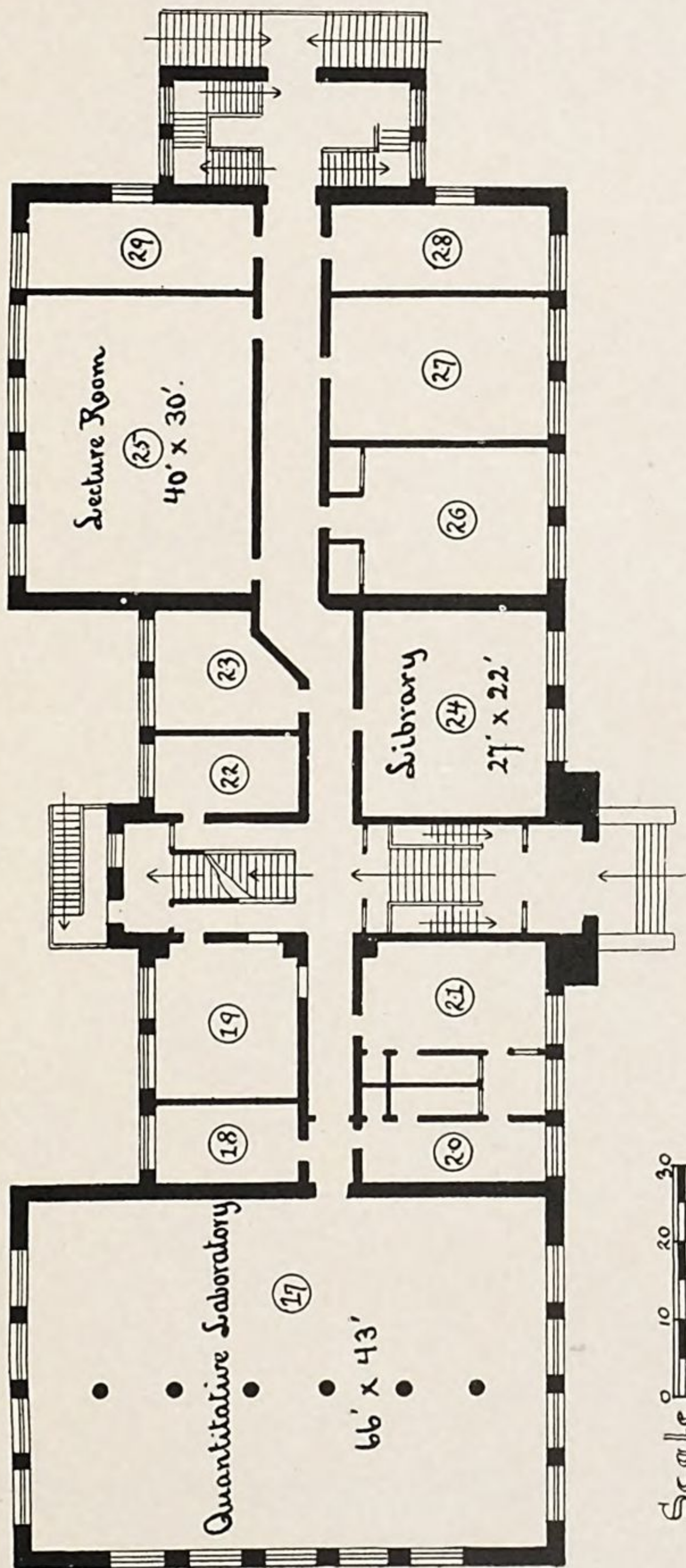
THE CHEMICAL LABORATORY OF CORNELL UNIVERSITY, ITHACA, NEW YORK.



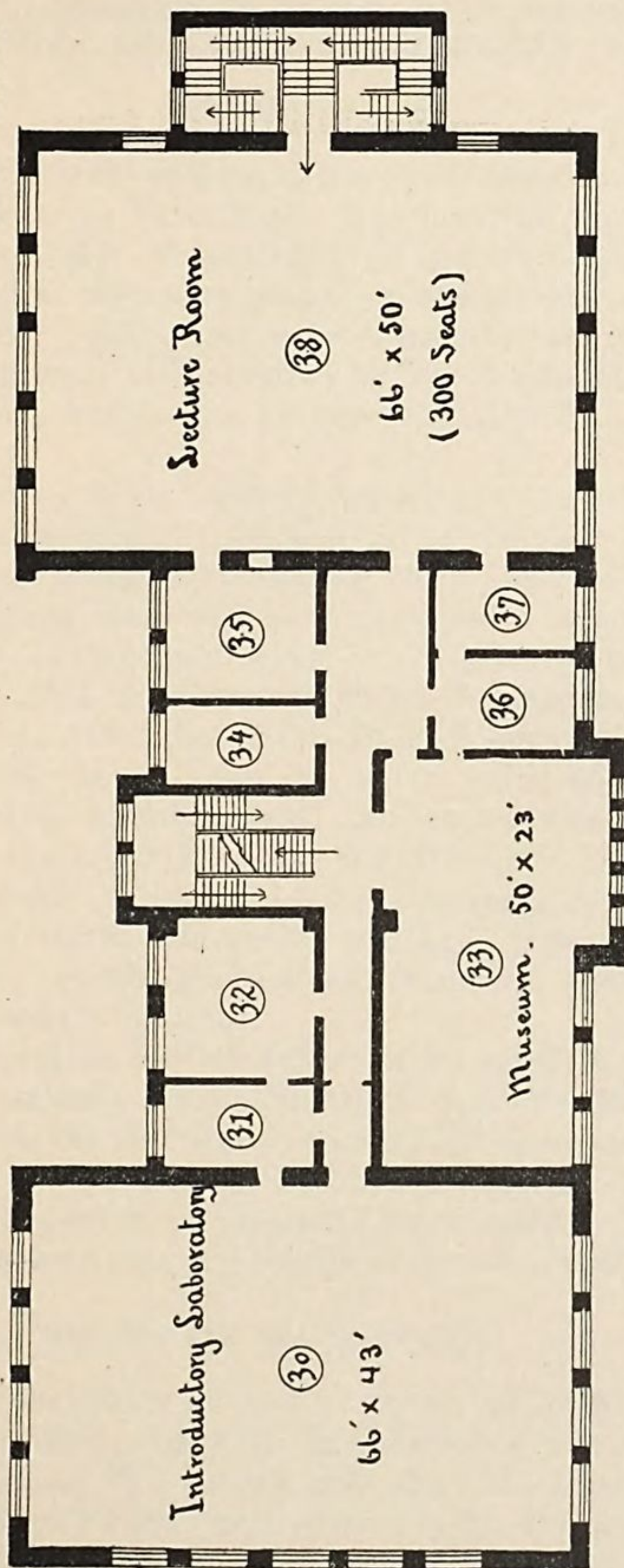


CORNELL UNIVERSITY—BASEMENT.

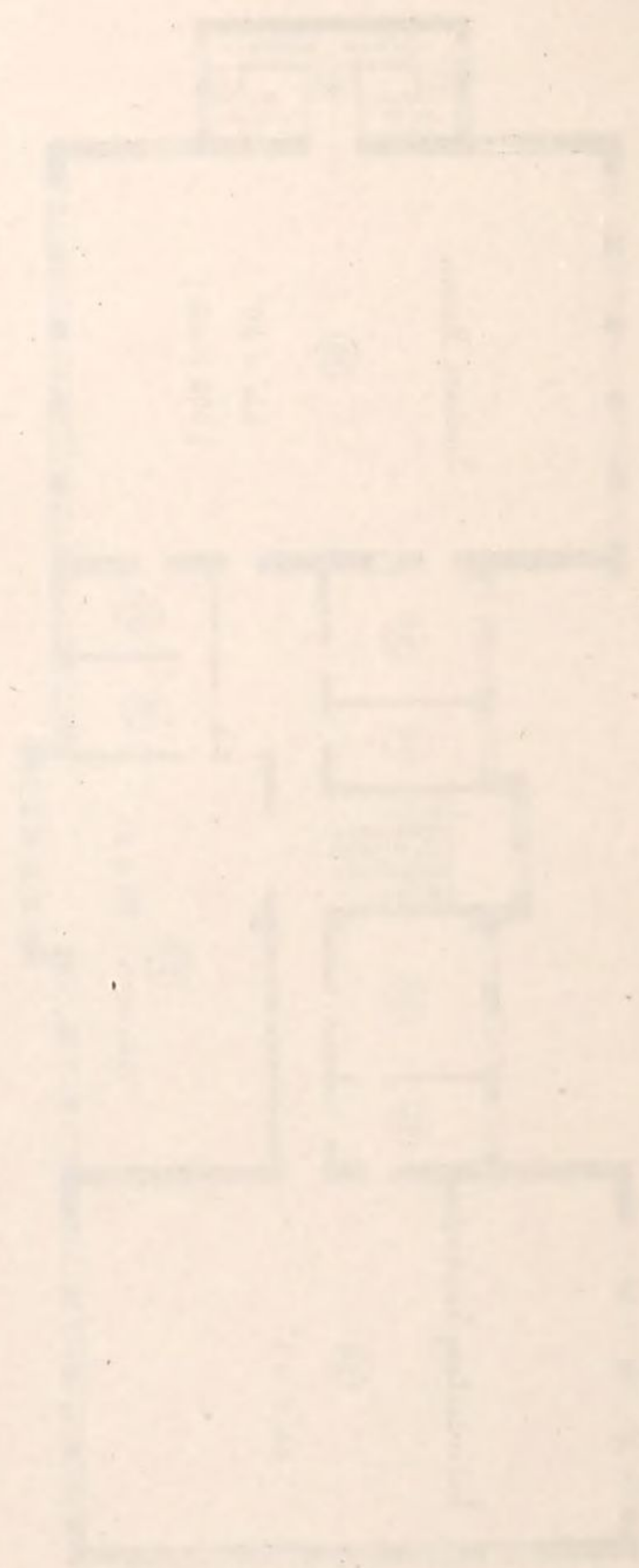




CORNELL UNIVERSITY—FIRST FLOOR.



CORNELL UNIVERSITY—SECOND FLOOR.



THE CHEMICAL LABORATORIES OF THE FEDERAL POLYTECHNIC
SCHOOL IN ZURICH, SWITZERLAND.

(With 15 plates.)

These laboratories were erected in the years 1884-'86, and were occupied in the fall of the latter year. The building was planned by Victor Meyer, professor of analytical chemistry, and G. Lunge, professor of technical chemistry, and the plans carried out by Architects Bluntschli and Lasius, professors of architecture in the school. The present description is condensed by W. H. Chandler from the official publication, which was prepared by the three last-named persons in 1889.

The main building is 86 metres long and 19 metres wide, with three stories and a basement. At each end of the main building are two wings, one extending front and the other back, each 30 metres long and 11.5 metres wide, with one story and a basement. Also from the back extends a central wing, but only of the height of the basement story. This arrangement makes it possible for all the main and side rooms to be thoroughly lighted and ventilated. The cubical contents of the building are 49,000 cubic metres and the floor area about 9,000 square metres. The cost of the building was 1,300,000 francs, which is $26\frac{1}{2}$ francs per cubic metre; in this are included the cost of the building, the surroundings, fences, etc., and the architects' fees, but not the cost of the land. The cost of fittings was 400,000 francs, which includes the furniture, machinery, and apparatus of the entire building.

The building contains the laboratory of technical chemistry, the pharmaceutical institute, the photographic institute, the silver and gold testing station, the laboratory of analytical chemistry, the agricultural chemical station, and the central seed station. The last two are entirely independent of the chemical departments. Each of the other departments are under the charge of a special professor.

THE COURSE IN CHEMISTRY.

The students of chemistry in the first year work in the laboratory of analytical chemistry, one term in qualitative and one term in quantitative analysis. The second year they are occupied in the laboratory of technical chemistry, especially for the production of chemical preparations. In the third year candidates for diplomas work one term in each laboratory. In this year the students are engaged partly in technical chemical analysis and partly in difficult preparations, so as to be able to reproduce substances as described in technical journals and in letters patent. In the fourth year the

student is chiefly engaged in independent work, assigned by and accomplished under the advice of their instructors.

Students in natural science and in mechanism also receive instruction in the laboratory of analytical chemistry.

THE COURSE IN PHARMACY.

The students in pharmacy work during the first year in the laboratory of analytical chemistry, and in the second year in the pharmaceutical laboratory.

THE GOLD AND SILVER TESTING OFFICE.

This does not serve for regularly carrying out the testing work, but for the practical examination of candidates for degree of federal assayer, prepared in other institutions and, if necessary, for the instruction in this branch. It is under the control of the professor of analytical chemistry.

THE PHOTOGRAPHIC INSTITUTE.

Instruction is here given in the theory and practice of photography to the students in the polytechnic school, and to others if room permits.

THE AGRICULTURAL CHEMICAL STATION.

This station was established in 1878, by the present director, Dr. E. A. Grete, and has grown to be one of the largest of its kind. The most of its work is the analytical control of commercial goods and food products, but its investigations extend over the entire field of agricultural chemistry. In 1888, 7,604 quantitative determinations were made here.

THE CENTRAL SEED STATION.

This was established by the present director, Dr. F. G. Stebler, as a private undertaking, in 1875, and in 1878 was assumed by the federal Government. Its object is to examine seeds for associations, private persons, and dealers, as regards their purity, their sprouting and other valuable qualities. This also has grown to be one of the largest of its kind. In 1888, 3,150 examinations were made, of which 1,278 were for residents of foreign countries.

HEATING.

The building is heated by steam, working under a pressure of 1 to $1\frac{1}{2}$ atmospheres, with direct radiation, electrical thermometers indicating to the engineer the temperature of the various parts of the building.

VENTILATION.

The ventilation is accomplished by means of a fan blower, which forces air into the rooms through flues in the walls. In winter the air is heated to 18°C . by passing over steam coils in chambers in the cellar, and in summer it may be cooled by running cold water through the same coils. Arrangements are also made for filtering the air and also moistening it if required. The vitiated air escapes through flues in the walls, which are provided with registers near the ceiling for summer and near the floor for winter use. The flues from the fume closets also afford exits in the laboratories; 40,000 cubic metres of fresh air per hour are supplied to the building. The boilers and ventilation apparatus are placed in the cellar.

VACUUM TRANSMISSION.

Two double-acting vertical air-pumps, of 270 millimetres diameter and 360 millimetres stroke, connected with a steam engine are placed in the boiler room, connect with 500 vacuum stopcocks of 5 millimetres opening. The pipes for transmission, of 60 to 80 millimetres diameter, are of cast-iron, of 7 to 50 millimetres are of lead. Vacuum gauges are placed in the four laboratories and in the boiler room.

DESCRIPTION OF THE LABORATORIES.

The main entrance leads to a large vestibule on the first story, from which, to the right, a corridor 3.5 metres wide leads to the technical laboratory, and to the left a similar corridor to the analytical laboratory. In the middle of the building, opposite the main entrance, is a small auditorium for forty students; area, 51 square metres.

THE LABORATORIES OF TECHNICAL CHEMISTRY.

On the right of the corridor are an ante room; a work room for an assistant; the professor's office, area, 21.7 square metres; his private laboratory, area, 62.5 square metres; his balance room, area, 20 square metres, and the main storeroom for apparatus and chemicals, area, 42.5 square metres. This last-named room is connected by a stairway with a storeroom in the basement and apparatus room on the second floor, and is provided also with a lift. At the end of the corridor a granite stairway leads from the cellar to the roof. To the right of the stairway is the library, area, 40 square metres; to the left is the toilet, and beyond is the weighing room for these laboratories, area, 23.1 square metres. The latter contains ten balances and one microscope.

The students' laboratories are in the wings at this end; one, toward the front, is for students of the second year, and is 29.6 metres long by 10 metres wide, with high arched windows, 1.7 metres wide,

on three sides of the room. On one of the long sides of this room is a projection which was intended for a fume room, but the fume closets were found sufficient. The fume closets are placed in the windows on the long sides of the room, two closets in each window, communicating with flues in the pillar between the windows. These flues are of acid-proof material, 17 by 26 centimetres and 14 by 17 centimetres, some extending from the basement and others from the first story to the top of the building. The bottom of the flues is a little below the bottom of the fume chamber, and an S-shaped lead pipe conducts the condensed vapors into the drain pipes. There are two openings in the flue from each fume closet, 12 centimetres diameter, one, near the bottom, loosely covered with an enameled lid having a hole 2 centimetres in diameter, the other, at the top, always open. This latter, which has an oblique connecting flue, is provided with a gas jet, though for ordinary work it is unnecessary to use this. Each closet is provided with two gas, one water, and one vacuum cocks, and a waste pipe for liquids.

There are two rows of double desks, sixteen in all, each accommodating four students; they are 2.76 metres long by 1.50 metres wide, giving to each student one-fourth of the space. They are of white pine, with oak tops; they have shelves above for reagents, on either side of a solid partition dividing the desks. On either side of a double desk, in the middle, is a waste box for reception of solids. On either end of desk is a semicircular porcelain sink, with a water cock. There are also four closets with double doors, eight drawers, four long drawers, extending through the whole width, for glass tubing, condensers, etc., eight gas and four vacuum cocks.

The laboratory in the rear is intended for students of the third year and others more advanced. It is 26 metres long by 10 metres wide. It is furnished similarly to the preceding, having, however, fourteen double desks; each student being allowed double the space that is permitted in the first-described laboratory. We find here a hydraulic press, a water motor with two stirring machines, and a funnel drying closet.

At the rear end of this laboratory is an optical room, area 16.9 square metres, with darkened walls and solid shutters for the windows; a spectroscope, a polariscope, and a photometer are placed here.

By the side of this room is a combustion room of the same size with stone table, an oxygen-gas holder, five combustion furnaces, cocks for the supply of gas, oxygen, and air, and a fume chamber of double sheet iron.

Leading to the left from the end of this laboratory is a covered piazza, open at the sides, which permits working in the open air.

In the basement under the last-mentioned laboratory is a room of the same area with stone tables on the window sides, flanked with

protruding pillars and arches, inclosed with glazed iron sashes, forming fume closets 3 metres long, by which the student is protected from hurtful gases. Each table has four gas, two water, and two vacuum cocks, and a gas flame in the ventilating flue. This laboratory is supplied with a steam-heated drying closet with six large fans, with hot and cold distilled water, and a small hydraulic press. This room is intended for operations that require more space than is afforded in the other laboratories. Each student chooses his place, which he relinquishes when his work is completed.

Back of this room is a gas room with northern light, area 16.7 square metres, and a room, area 32 square metres, for independent workers, fitted completely like the large rooms, but isolated for work producing very penetrating odors.

At the front end of the large laboratory is the ether room, area 20 square metres, intended for operations on very dangerous and easily ignited liquids. There is no gas here, only steam and water. The steam bath has three large openings, with tin ventilating tubes over each opening. There is also a steam extraction apparatus and a steam sand bath.

On the other side of the stairway is a room for technical gas analysis, area 39 square metres. Here, also, is a large vacuum filtering apparatus.

The rooms for dyeing and calico printing have area of 43.7 square metres and 42 square metres. They are supplied with apparatus for testing colors, consisting of steam baths, a drying closet, steam apparatus with pressure, a dye boiler, small printing machine, etc., the same arrangements as are used in the color-testing departments of calico factories. There is also a storeroom, area 42 square meters, connected by stairway with another above.

Across the corridor is the electro-chemical room, area 19 square metres, with a 2 horse-power steam engine and two Siemens dynamo machines, one giving 10 to 13 volts and 100 ampères and the other 65 volts and 10 ampères; also an electrical testing machine after Classen, and all necessary apparatus for electrical work.

Beyond this is the machinery room, area 85 square metres, with the following machines: a bullet machine of cast-iron for pulverizing hard substances; a small rolling-mill with hard porcelain rolls; a rolling-mill with smooth, and one with rough rolls; a compression pump for gas, of bronze, 40-millimetre piston, 130-millimetre stroke, 30 atmospheres pressure; a shaking machine; a hydraulic press, 400 atmospheres pressure, for liquids or solids; a metal lathe for the machinist; a small centrifugal for hand work, and a laboratory filter-press.

Beyond this room is a storeroom, area 43 square metres. In the middle wing are two smelting rooms, area 93 square metres and 82 square metres. Here are two rows of furnaces, of different forms, for

coke for high temperatures, some of which are supplied with an air-blast pipe 90 millimetres diameter.

There are also an evaporating battery for large dishes, with special arrangements for carrying off the condensed water and a valve for each dish, and the whole inclosed in a glass case, with steam vent and with partitions and a sliding window to each compartment; a double-acting compression pump, cylinder 120 millimetres diameter, 180-millimetre stroke, and an air chamber 1 metre diameter and 2.5 metres high, of which the conducting pipes to each room are of iron, three-eighths to 2 inches diameter; a large copper kettle, heated by coal or coke, and a copper still of 200 litres capacity, with a copper tube condenser.

The photographic department is beneath the front technical laboratory, and consists of a day room, area 64.5 square metres, to which is attached a small glass room 6.5 by 3 metres, and below—reached by winding stairs—the dark room, of the same size as the day room above. In the day room are closets for apparatus and the collections of chemicals, working tables, retouching arrangements, a washing trough, and a smaller dark room. The larger dark room below is divided into four rooms, which are closely connected; the first, in which is the stairway, contains two closets with compartments for thirty-two students, in which all articles necessary for work can be kept under lock; the other three rooms are dark rooms, with tables and washing arrangements. There are also a plate-drying box, a drying place, and positive enlarging appliances. Nine operators can work at once. The department is supplied with thirty-two complete outfits for photographic work in the dark room, seven complete portable cameras and accessories, 13 by 18 centimetres; one studio camera, 21 by 27 centimetres, with iron support and several objectives; four retouching desks; three microphotographic apparatus, with illuminating attachment; and one pinascope for enlarging.

In the cellar are a number of preparation rooms, a large ice box, and a large ice closet for crystallizations, etc.

The second story is reached by a double granite stairway from the large central vestibule and by the granite stairways in the end wings. On the technical side we find the large lecture room for technical chemistry, 17.66 by 12.92 metres and 8 metres high. It is lighted by side windows, which can be completely darkened by black curtains hung upon rollers. The seats are arranged in amphitheater form, with one hundred and sixty seats. The space beneath the rises for the seats is used for storing large wall plates, etc. The experiment table is 9 metres long, and is provided with all conveniences, cocks for vacuum, compressed air, and steam. Two small flues are connected with the table for fumes. On the back wall is placed part of the metallurgical collection. The other wall space is used for displaying plates and charts. There are three side rooms;

a preparation room, area 25.5 square metres, with skylights, containing preparations of scientific interest and a large collection of card-mounted patterns to illustrate dyeing; an apparatus room, area 45.5 square metres; and a third room, area 23.6 square metres, for storage. The apparatus room is connected by stairway with the professors' weighing room below.

Adjoining the main vestibule is a conference room, area 31.2 square metres.

At the south end of the building, on this story are six rooms, with kitchen, serving as a residence for the first assistant.

The large vestibule is floored over, 4 metres above the second floor, thus affording a hall 4 metres high and an area of 366 square metres, lighted by a skylight and windows. Here is placed the museum of technical chemistry, which is placed in vertical and flat cabinets, on open tables, or upon the walls, as serves best. The specimens are all carefully labeled, singly and in classes, with charts and tables hung in the vicinity, giving all necessary information. Some of the principal classes are: Textile industry, with vegetable and animal fibres of all kinds, dyeing, calico-printing, etc.; dyeing materials, vegetable, animal, and mineral colors; illuminating materials, oils, fats, mineral oil; soaps, coal industry, building materials, glass and porcelain, salt and potash industry, metallurgy, etc.

Many of these specimens have been furnished by the manufacturers of different countries on application of the director, and some by societies. They illustrate all parts of chemical technology, including the raw products of all countries, series of intermediate and final products, showing the entire course of manufacture.

On this floor are also three rooms, used as a dwelling by the janitor, and single rooms for unmarried assistants.

THE PHARMACEUTICAL DEPARTMENT.

This originated in the technical department, with which it is still connected in its general management, in the library, weighing room, and preparations room. The pharmaceutical laboratory is situated upon the first story, opposite the private laboratory of the professor of technical chemistry, area 84.9 square metres. It has fourteen working places, and three fume chambers, arranged similarly to the technical laboratories, the reagent bottles being especially arranged for the pharmacist. There are also places for general reagents, drying closets, presses, and a complete pharmaceutical laboratory apparatus, arranged for both direct and steam heating.

Adjoining this laboratory is the pharmaceutical museum and microscopical room, area 42.2 square meters, and two small storerooms. The museum contains a collection of drugs of the European *Materia Medica* and a greater part of the raw medicinal material; also, specimens of original investigation in this department. On the sec-

ond story to the left of the main vestibule is a room, area 31.2 square metres, containing a collection of pure pharmaceutical preparations. The small lecture room on the first story, opposite the main entrance, is intended primarily for lectures on pharmacy, and has, upon the left hand, a preparation room, containing a hand collection of officinal drugs of the pharmacopœia, and upon the right the private room of the professor of pharmacy, his private laboratory, area 19 square metres, being in the basement. In his private room is the finer physical apparatus and the special library of pharmacy.

THE LABORATORIES OF ANALYTICAL CHEMISTRY.

This is under the direction of the professor of analytical chemistry. As here is given instruction in analytical chemistry to students of general and technical chemistry, and also to students of pharmacy, natural history, and mechanism, more working places are required, of which one hundred and sixty-six are provided, and less room for special operations, and the arrangements are simpler in detail.

It occupies the left-hand end or northern wing of the buildings. The important rooms are similar to those in the technical department already described, as regards the working desks, fume closets, gas, water, vacuum, lighting, and heating appliances.

The front laboratory has sixty-four working places for students of the first year. The rear laboratory has fifty-eight working-places for more advanced students and for students of the third year and of organic chemistry. The beginners are allowed a single place with room for thirty reagent bottles, and the advanced students are allowed a double place so far as possible.

Beyond the rear laboratory is the combustion room, containing gas holders for oxygen and air, where seven elementary analyses can be made at one time.

Both laboratories are provided with steam drying closets and blowing tables. The reagents are kept in large flasks, with glass siphons and stop-cocks, from which the students supply their bottles. In many fume closets are constant water-baths with protection from dust. The front weighing room contains fourteen balances for beginners, the rear room seven balances for advanced students. The "cannon" room serves for heating substances in closed tubes, and the dark room for optical work. One room with indirect light is used as a storeroom for substances and mixtures for analysis by the students. There are also on this floor the private laboratories and rooms of the professor and the first assistant, a room intended for physical chemistry, but now used as a private laboratory for two assistants, the library, storerooms, and toilet room.

In the basement are found three preparation rooms. Here also is

a general workroom beneath the rear laboratory, with stone tables and large fume closets similar to the room in the technical wing. Here are placed evaporating batteries for beakers and evaporating dishes similar to those in the technical laboratories; a drying apparatus and an ether distilling apparatus; a distilling apparatus in which pure distilled water can be prepared, and which can also be used for distilling larger quantities of fluids in a vacuum. In the rear of this room is a room for advanced workers and one for electrical chemistry and gas.

In the lower corridor is a lecture room, area 66 square meters, with seventy-two seats, an experiment table, and a preparation room. There are rooms for night work and for independent workers.

In the central wing are found the pyrochemical room with several furnaces, and behind this the laboratory for the students of mechanism, who take only elementary chemistry. This latter contains forty working places, which are smaller and more simply arranged than those of the large laboratories.

The fume closets are covered with glass plates and the bottoms are of white enameled lava plates, which are more cleanly and better resist the action of heat and chemicals, but are more expensive.

The second story contains the large lecture hall, the apparatus collection room, and the preparation room, similar to the technical department. The experiment table and the preparation room are necessarily more elaborately appointed.

The assistants and the janitor's dwellings are the same as in the other wings.

THE GOLD AND SILVER TEST STATION.

On the forward side of the corridor, in the basement, are four rooms of this branch, combined area of 102 square metres. The first room, with two windows, is used for the wet silver test. The other rooms are used for furnace assay, parting of gold and silver, and weighing rooms, and contain the necessary apparatus, including muffles heated by gas and by coke.

THE SWISS AGRICULTURAL CHEMICAL STATION.

This is situated in the basement and cellar of the northwest wing, occupying an area of 300 square metres. In the front, to the left of the corridor, are the director's room and private laboratory, containing a dark room, also the library and the collections. To the right of the corridor are the laboratories; one for the determination of soluble phosphoric acid, with large revolving titration apparatus for ten tests by molybdate solution, the large laboratory opposite being used for determinations of insoluble phosphoric acid. In the latter-named room are three double tables, for four assistants, and four fume closets, placed against the pillars, containing sand and

water baths ; distilled water is kept in large glass flasks, into which it is pumped from the cellar. Two water-blowing apparatus drive a quadruple blower, useful for many determinations. A small room serves for potash determinations and another for other determinations. The combustion and drying furnaces are placed in the fume closets, and the distillation apparatus in the center. The weighing-room contains six balances. A washing room and an office completes this floor.

In the cellar are the rooms for preparation of solutions, storerooms, and apparatus for preparing samples. There are two drying closets, one heated by steam and one by water. There is a feed-cutting table, a Gruson Excelsior mill, and a porcelain roller mill, the latter for pulverizing superphosphates, so as to avoid contact with iron, the whole driven by a water motor. A large still furnishes the distilled water. The rest of the cellar is used as a special laboratory for technical workers and as storerooms.

THE CENTRAL SEED STATION.

This is situated in the basement and cellar of the southwest wing, to the side of which is attached a hot-house. It contains a large laboratory, area 66.8 square metres, with six working tables, 2 metres long, placed in the windows, four balance tables, a sieve with water motor, and closets for collections.

The thermostatic room is next with five thermostats for the examination of the sprouting qualities of seeds ; these contain two hundred and eighty porcelain cells, each holding about two hundred seeds ; the heating is accomplished by gas, regulated by a self-regulating apparatus, and the temperature can be raised and lowered at regular intervals by clockwork. The apparatus room is opposite, and across the corridor is the office and collection room, area 45.6 square metres, the control chamber, and the director's room and library.

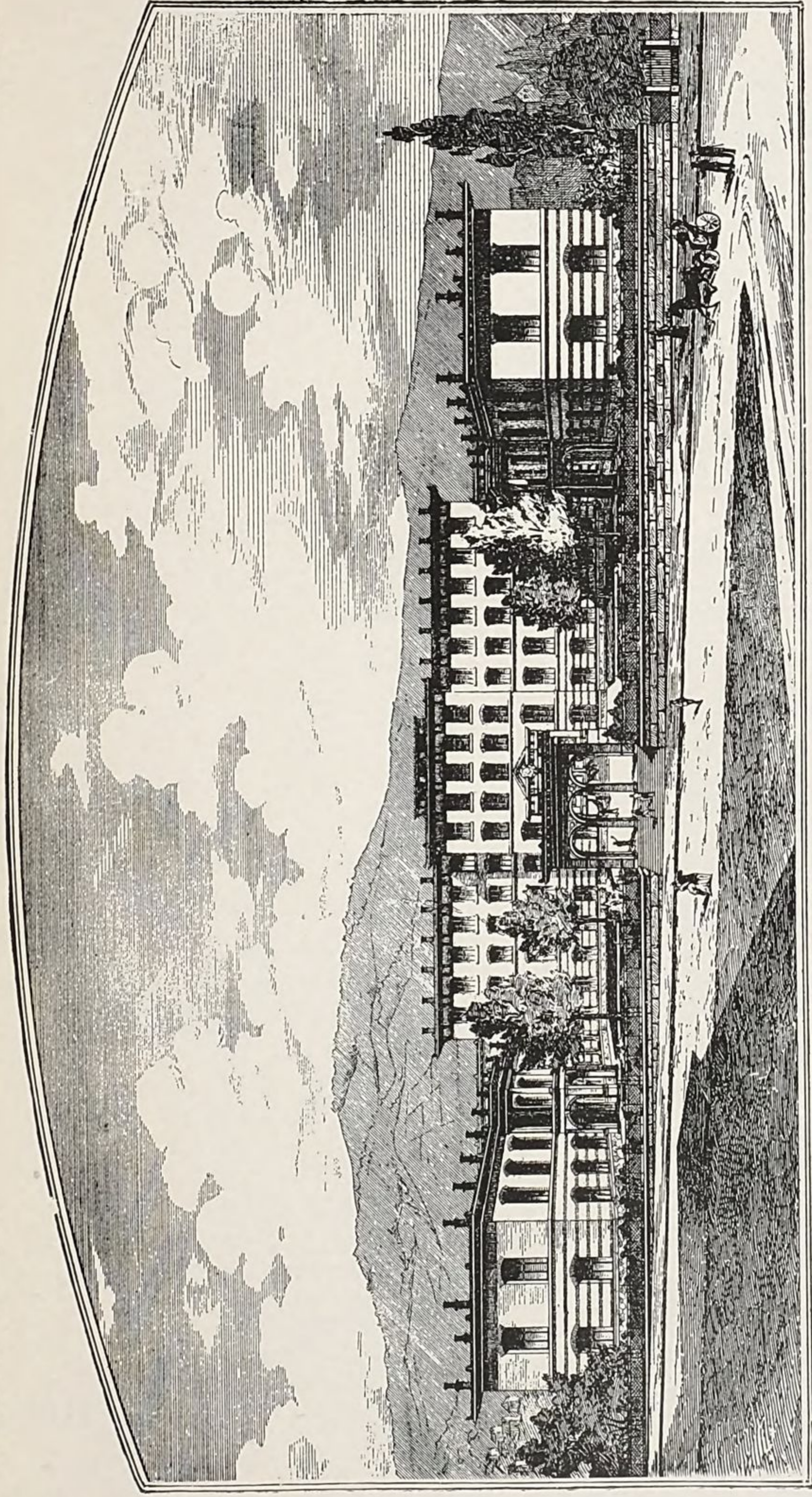
In the cellar are the steam room and apparatus for sterilizing the porcelain cells, the drying room, apparatus for distilling water, working places for the gardener, packing room, preparation room, the dark room, and the sprouting rooms ; of the latter the larger is kept at 20° C. and the smaller at 28° C., both being heated by warm water pipes, which are heated by means of two gas stoves. In the smaller room a thermoelectrical indicator shows the variations from the desired temperatures.

The hot-house serves to test the sprouting qualities in the light and the culture test. Outside is space for raising plants in the open air and in hot-beds. In the neighborhood is provided a farm of 20 acres for experimental purposes, and one of 25 acres on the Fürsten Alps, near Chur, 1,782 metres above the sea, for Alpine food plants.

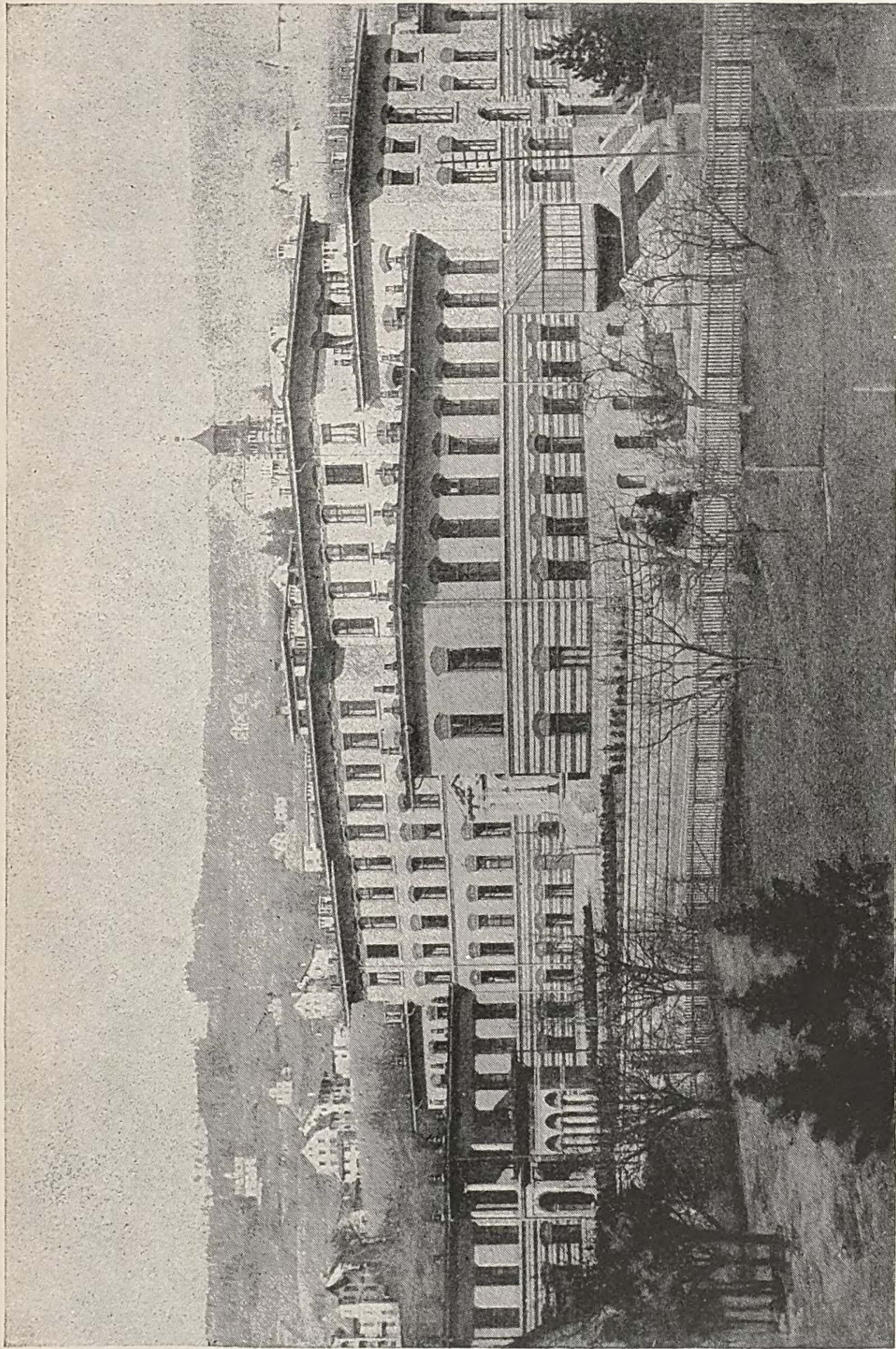
APPLIANCES AND PRODUCTS OF METHODS EMPLOYED FOR THE PRESERVATION OF WOOD.

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THE CHEMICAL LABORATORY OF THE FEDERAL POLYTECHNIC SCHOOL IN ZURICH, SWITZERLAND—FRONT VIEW.

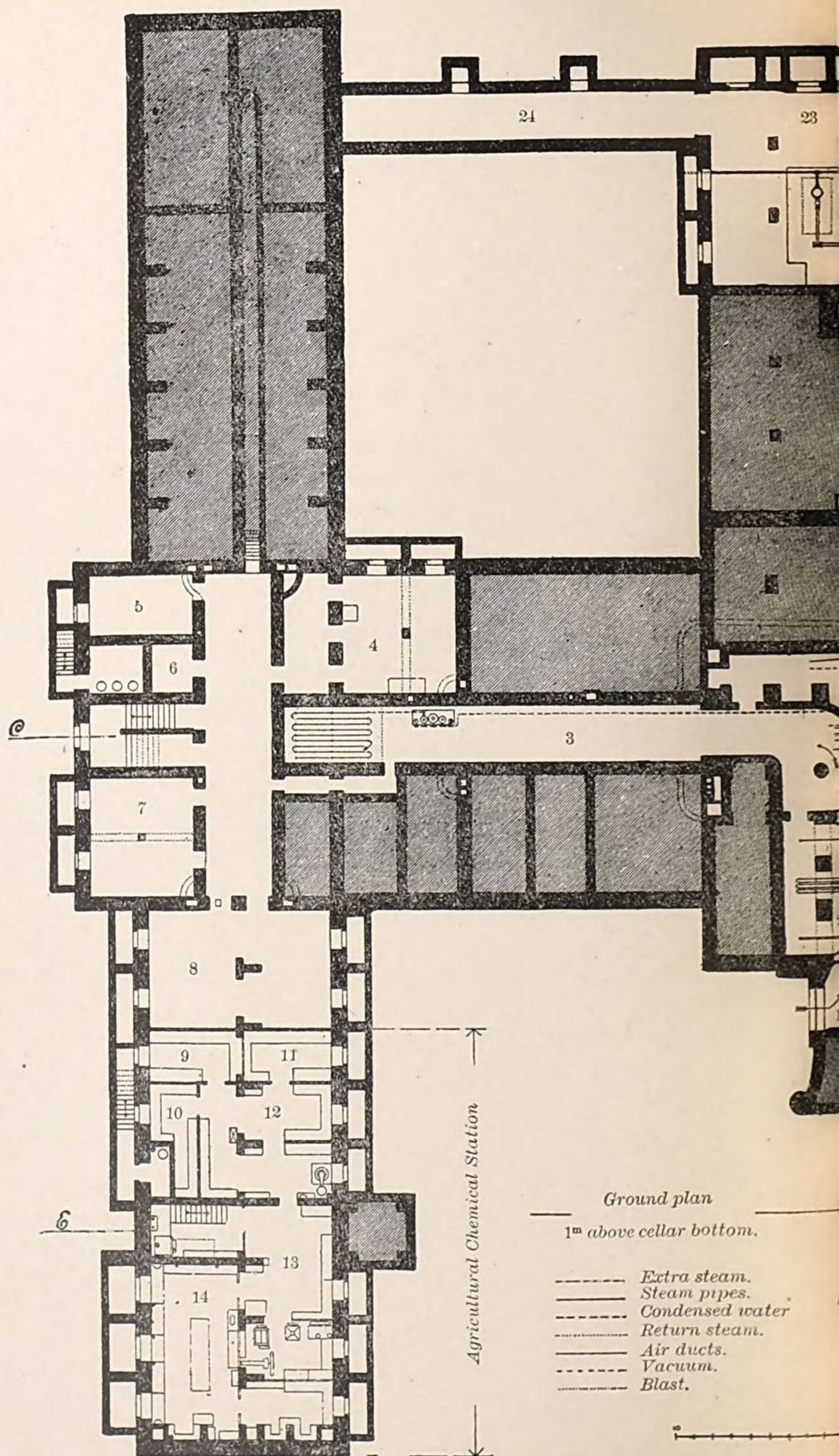


POLYTECHNIC LABORATORY, ZURICH—FRONT AND END VIEW.

PLATE XCII.

CELLAR

- | | |
|---------------------------------|------------------------------|
| 1. Air entrance. | 18. Store room. |
| 2. Air chamber. | 19. Private cellar. |
| 3. Cold air canal. | 20. Gas meter. |
| 4. Store room. | 21. Store room. |
| 5. Private cellar. | 22. Hot passage. |
| 6. Gas meter. | 23. Boiler room. |
| 7. Store room. | 24. Coal bins. |
| 8. Acid store room. | 25. Photographic dark rooms. |
| 9. Store room. | 26. Dark room. |
| 10. Acid room. | 27. Sprouting room. |
| 11. Testing room. | 28. Hot sprouting room. |
| 12. Distillation room. | 29. Preparation room. |
| 13. Room for preparing samples. | 30. Packing room. |
| 14. Special laboratory. | 31. Steam room. |
| 15. Private cellar. | 32. Work room. |
| 16, 17. Warm air canal. | |



Ground plan

1^m above cellar bottom.

- Extra steam.
- Steam pipes.
- Condensed water.
- · - · - Return steam.
- Air ducts.
- Vacuum.
- · - · - Blast.

0 1 2 3 4 5 6 7 8 9 10

Reduction

POLYTECHNIC LABORATORY

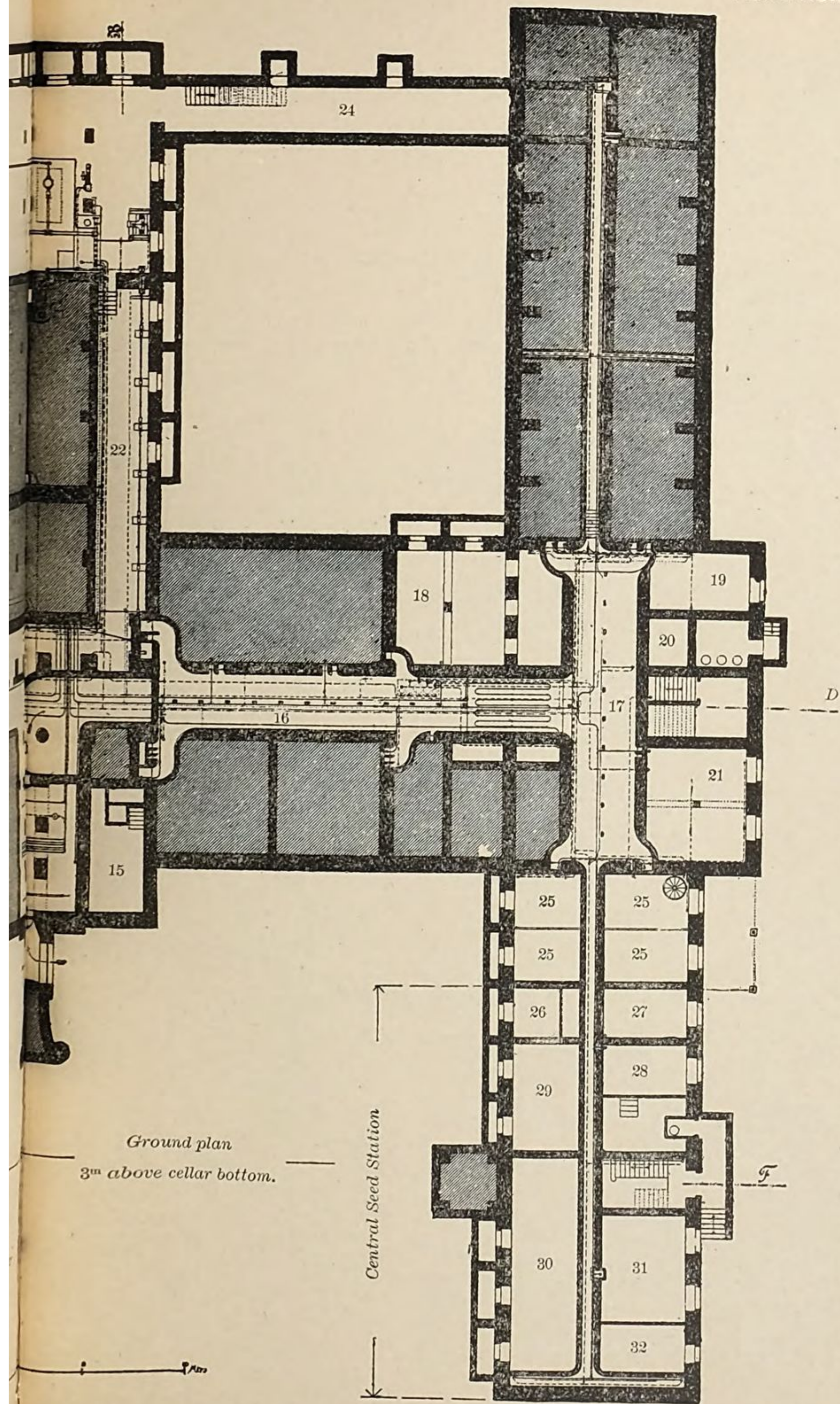
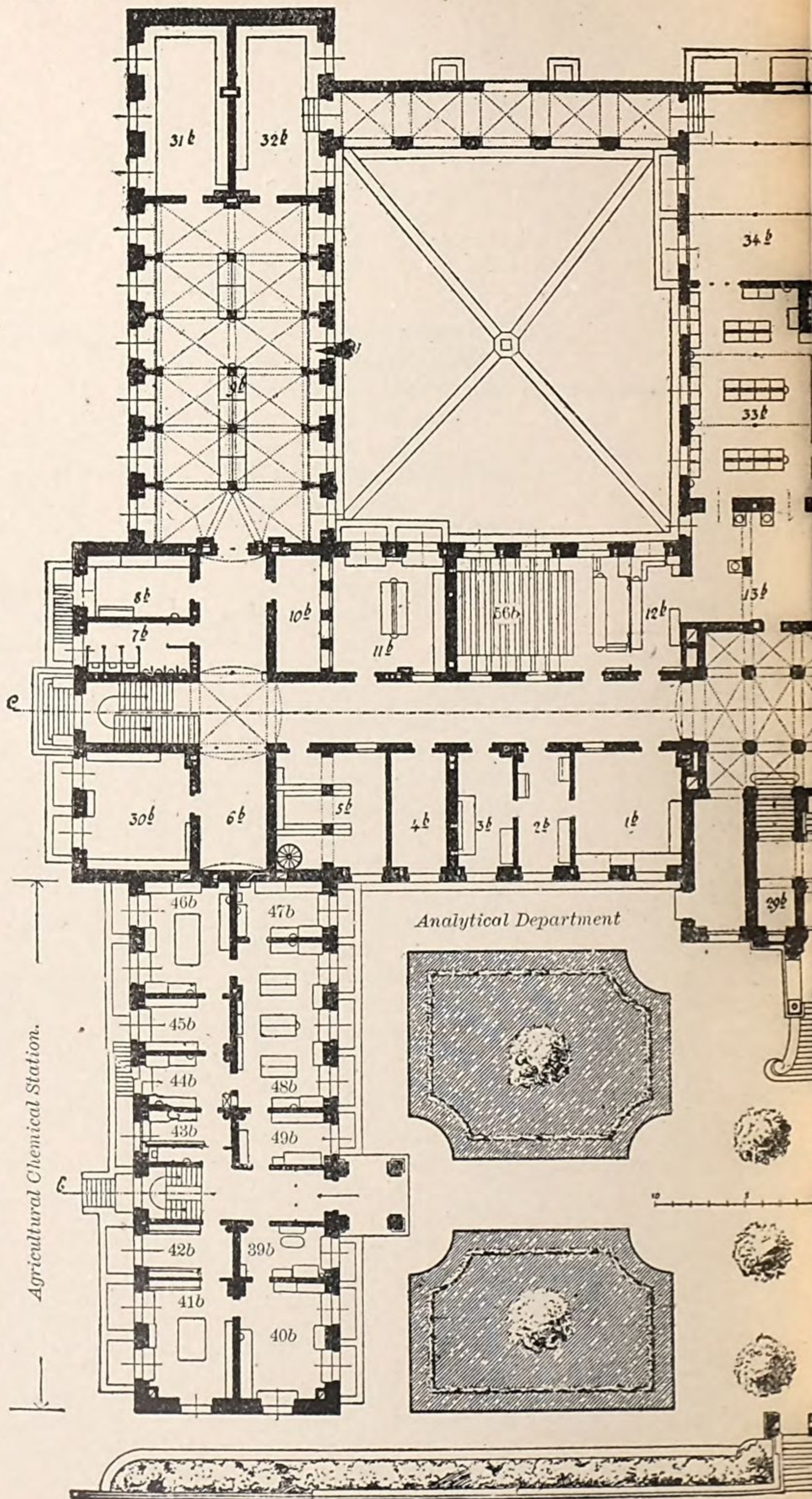




PLATE XCIII.

BASEMENT.

- | | |
|---|---|
| 1b, 2b, 3b. Assay laboratory. | 31b. Advanced workers' room. |
| 4b. Assayer's room. | 32b. Electrolytic room. |
| 5b. Glass room. | 33b. Chemical laboratory for students in mechanism. |
| 6b. Supply room. | 34b. Work room. |
| 7b. Toilet. | 35b, 36b. Smelting rooms. |
| 8b. Gas room. | 37b. Gas room. |
| 9b. Large laboratory. | 38b. Advanced workers' room. |
| 10b. Store room. | 39b. Director's room. |
| 11b. Laboratory. | 40b. Director's private laboratory. |
| 12b. Preparation room. | 41b. Museum. |
| 13b. Pyrochemical room. | 42b. Library. |
| 14b. Evaporating room. | 43b. Wash room. |
| 15b. Machinery room. | 44b. Soluble phosphoric determinations. |
| 16b. Electro-chemical room. | 45b. Balance room. |
| 17b. Store room. | 46b. Nitrogen determinations. |
| 18b. Large laboratory. | 47b. Potash determinations. |
| 19b. Ether room. | 48b. General laboratory. |
| 20b. Toilet. | 49b. Office. |
| 21b. Technical analysis. | 50b. General laboratory. |
| 22b. Photographic room. | 51b. Thermostatic room. |
| 23b. Store room. | 52b. Apparatus room. |
| 24b. Laboratory of professor of pharmacy. | 53b. Director's room. |
| 25b, 26b. Dyeing and calico printing. | 54b. Director's laboratory. |
| 27b. Attendant's room. | 55b. Office and library. |
| 28b, 29b. Ante rooms. | 56b. Lecture Hall. |
| 30b. Supply room. | |



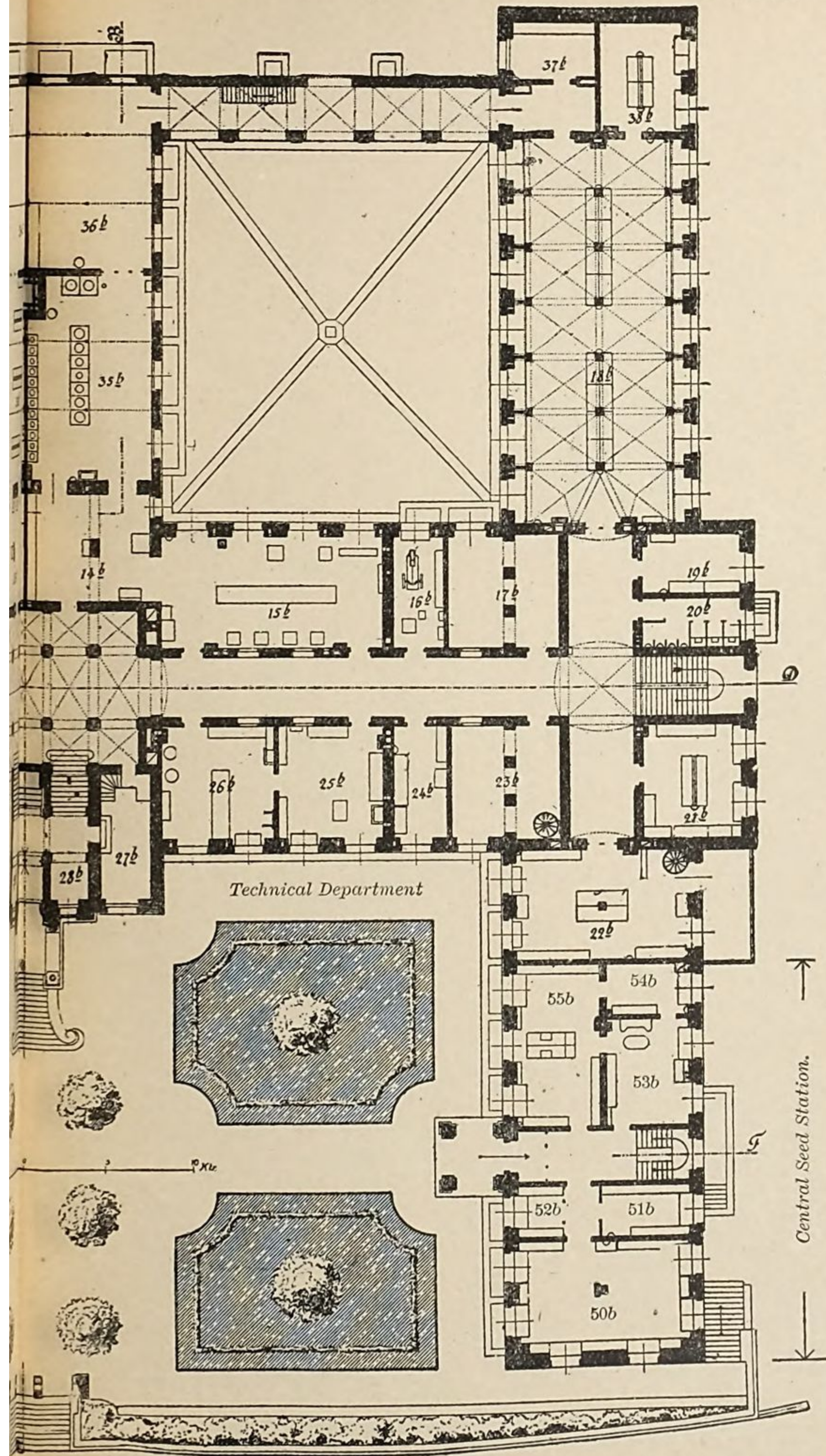
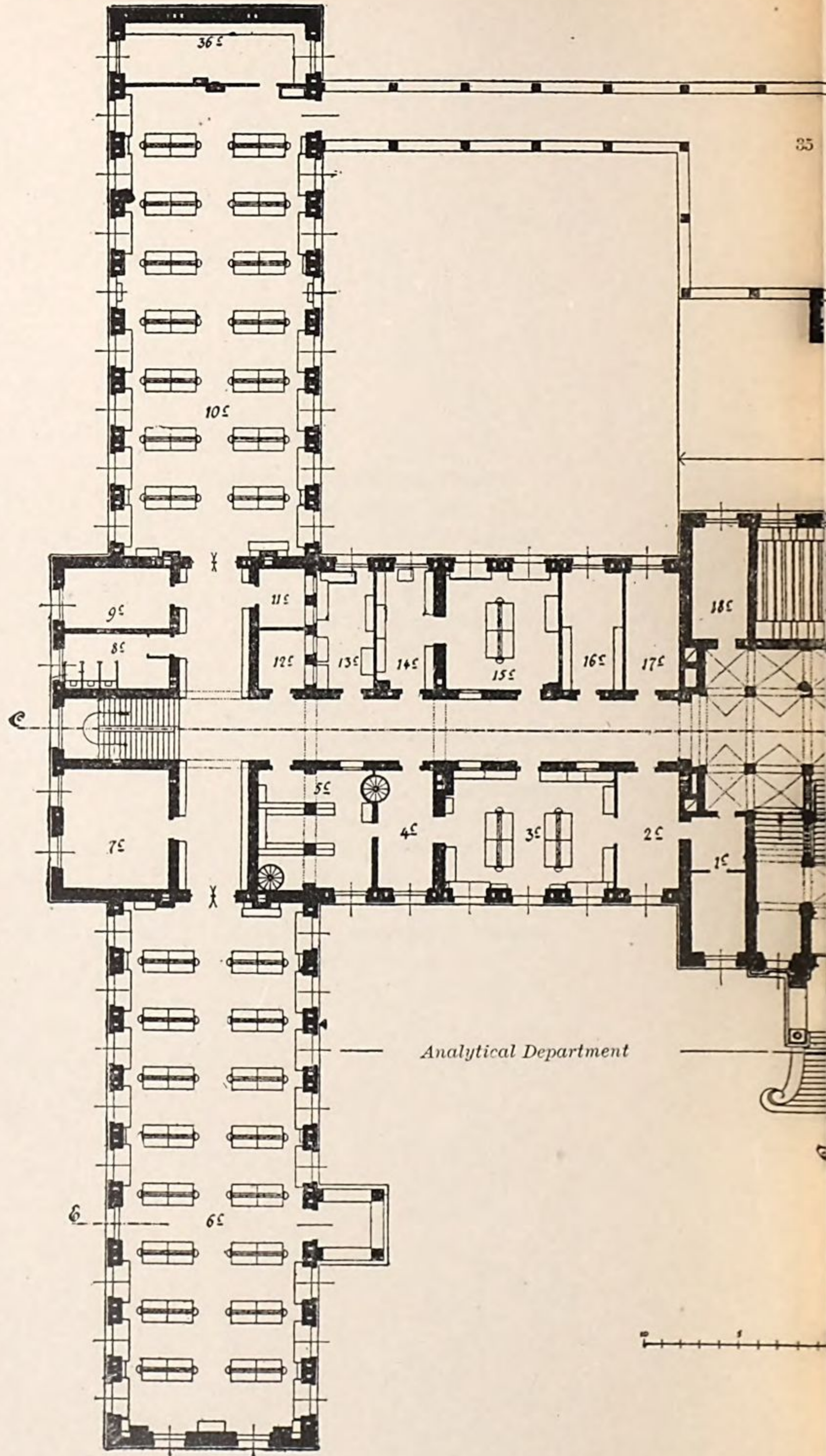
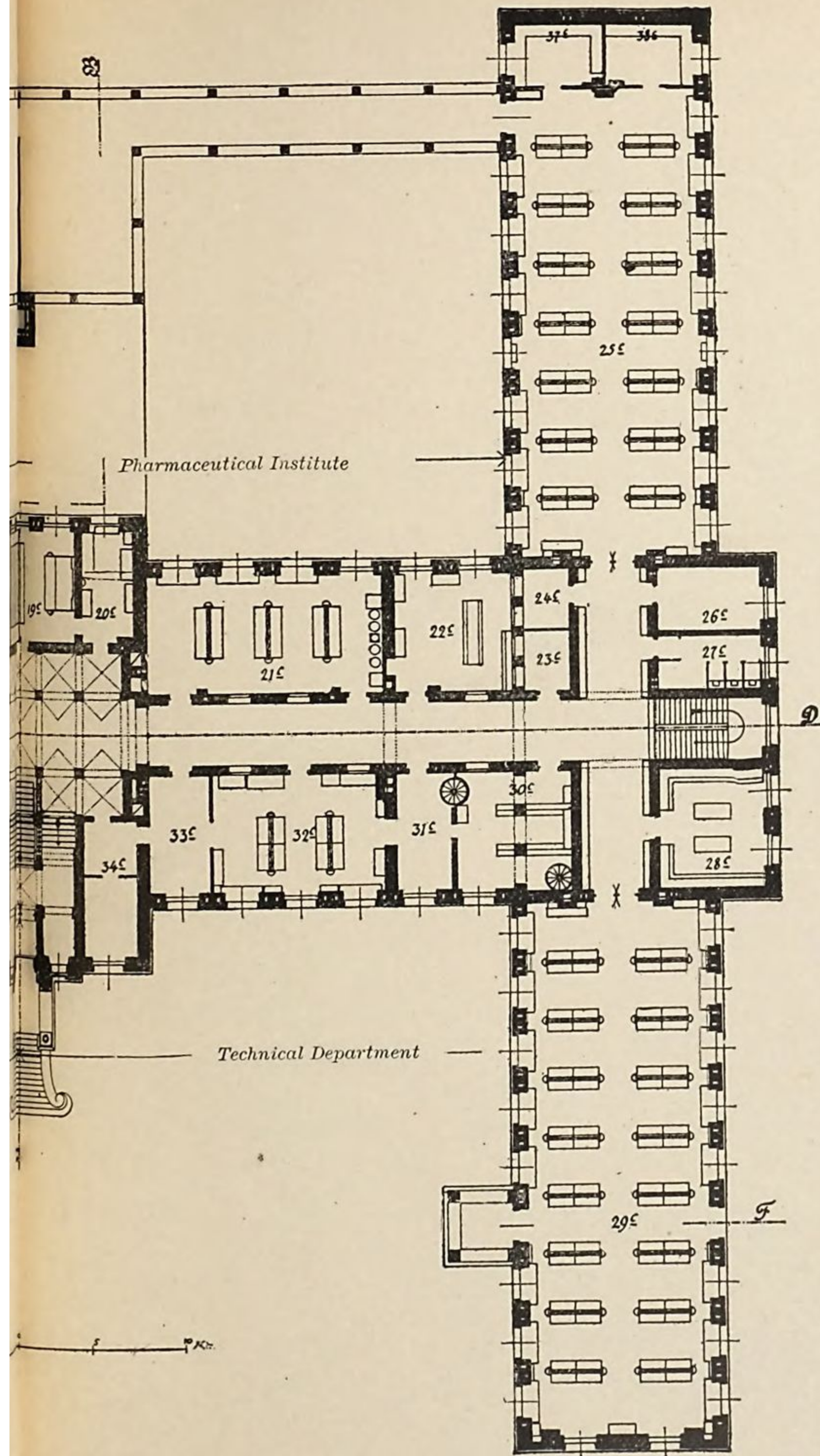


PLATE XCIV.

FIRST STORY.

- | | |
|---|----------------------------------|
| 1c. Assistant's room. | 19c. Small lecture room. |
| 2c. Professor's room. | 20c. Preparation room. |
| 3c. Professor's private laboratory. | 21c. Pharmaceutical laboratory. |
| 4c. Professor's balance room. | 22c. Pharmaceutical museum. |
| 5c. Store room. | 23c, 24c. Store rooms. |
| 6c. Analytical laboratory. | 25c. Technical laboratory No. 1. |
| 7c. Balance room. | 26c. Balance room. |
| 8c. Toilet. | 27c. Toilet. |
| 9c. Cannon room. | 28c. Library. |
| 10c. Organic laboratory. | 29c. Technical laboratory No. 2. |
| 11c, 12c. Store rooms. | 30c. Store room. |
| 13c. Wash room. | 31c. Professor's balance room. |
| 14c. Balance room. | 32c. Professor's laboratory. |
| 15c. Instructor's laboratory | 33c. Professor's room. |
| 16c. Library. | 35. Colonnade. |
| 17c. Iron closet. | 34c. Assistant's room. |
| 18c. Room of the professor of pharmacy. | 36c, 37c. Combustion rooms. |
| | 38c. Optical room. |





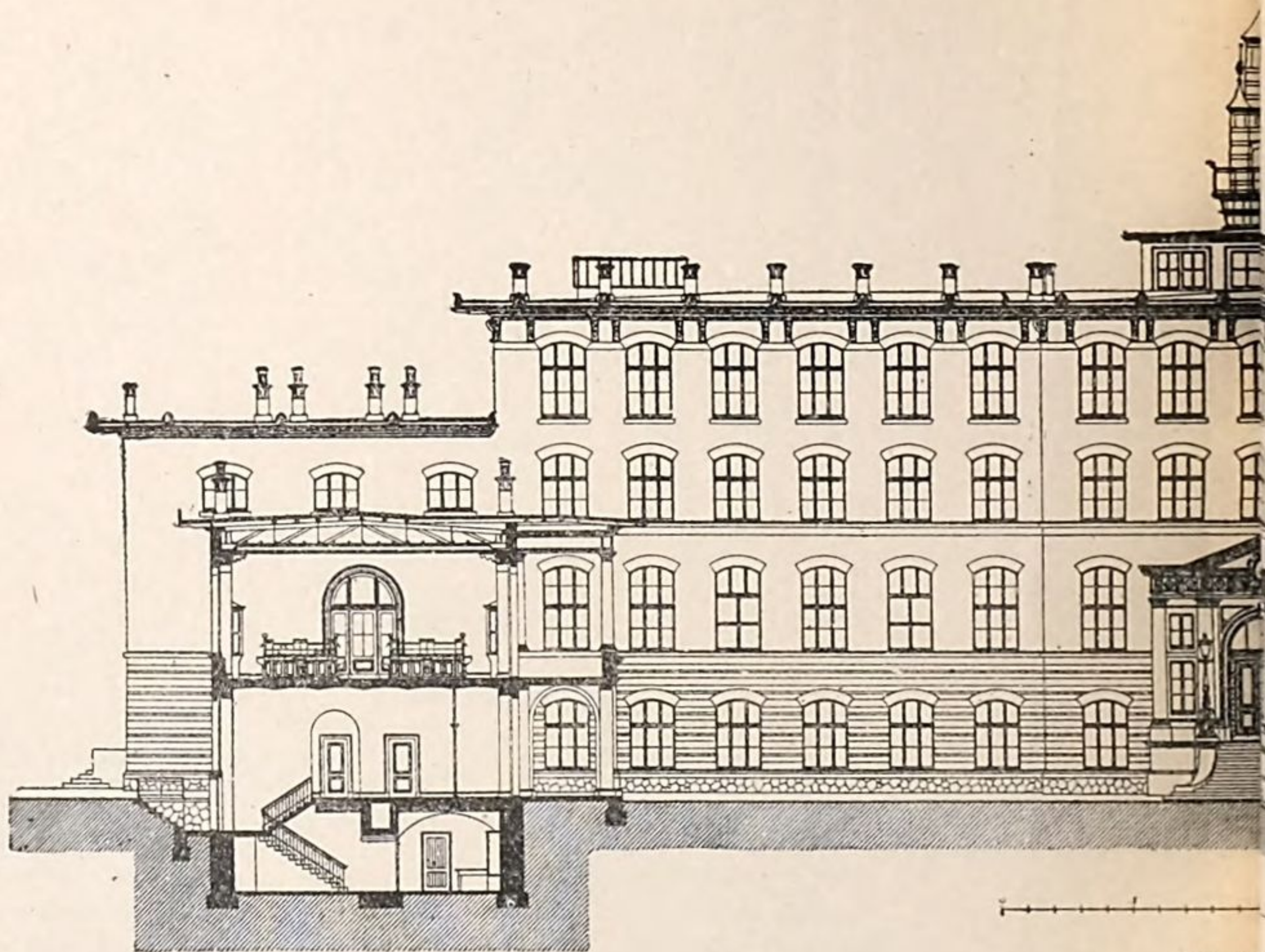
ZURICH—FIRST STORY PLAN.

PLATE XCV.

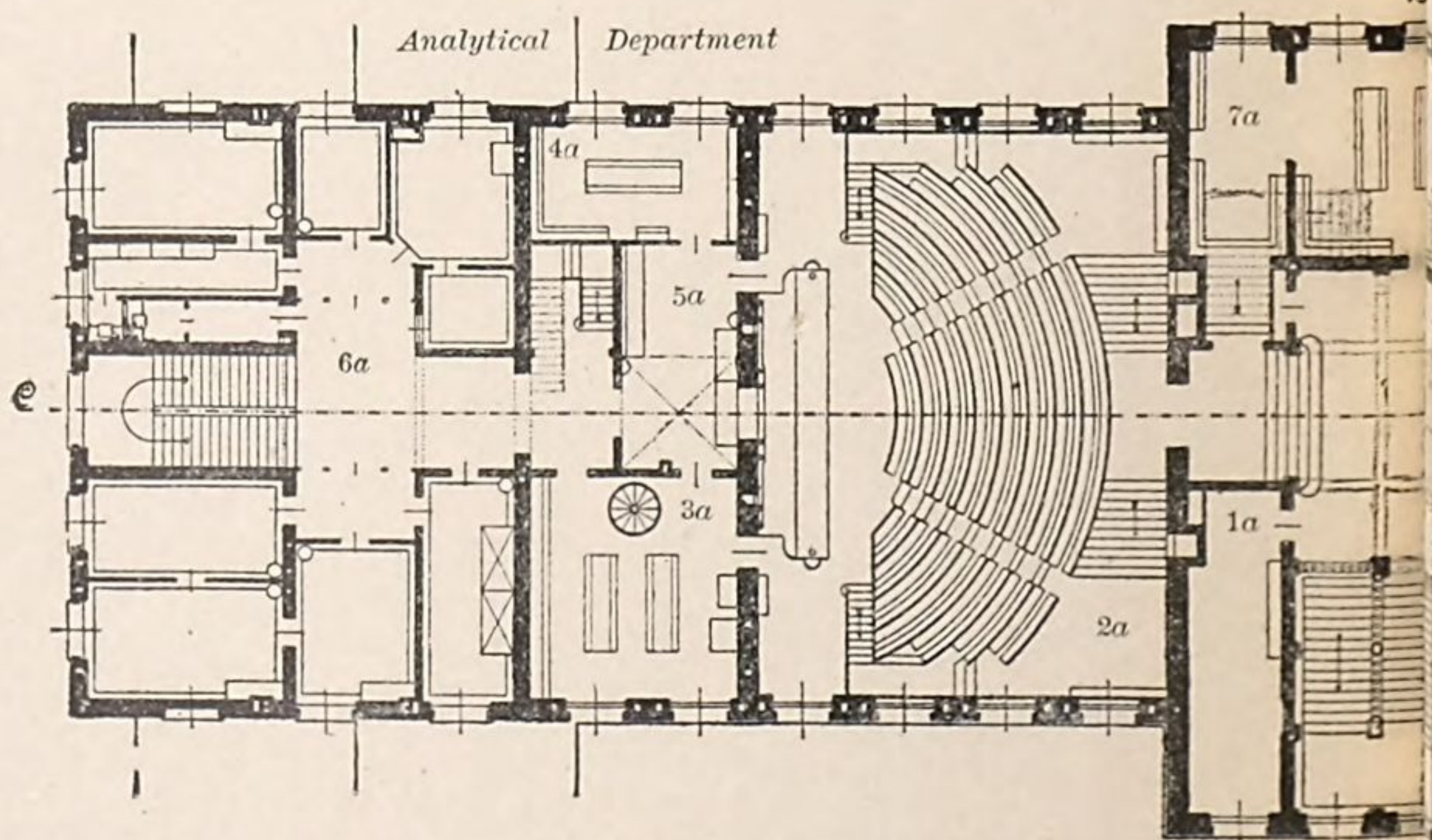
SECOND STORY.

1*a.* Pharmaceutical museum.
2*a.* Chemical lecture room.
3*a.* Apparatus room.
4*a.* Lecture specimens.
5*a.* Preparation room.
6*a.* Assistant's residence.
7*a.* Chemical museum.

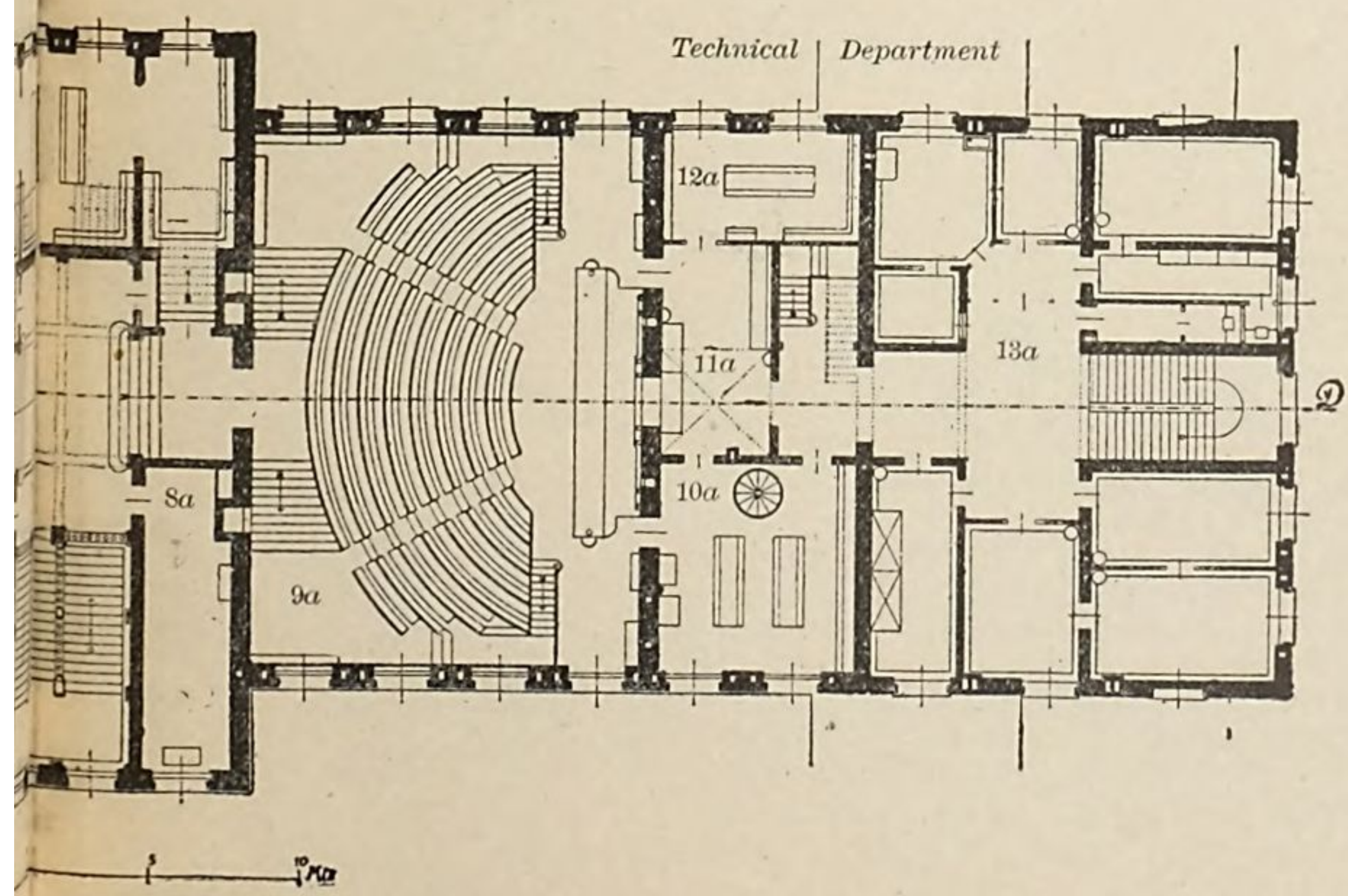
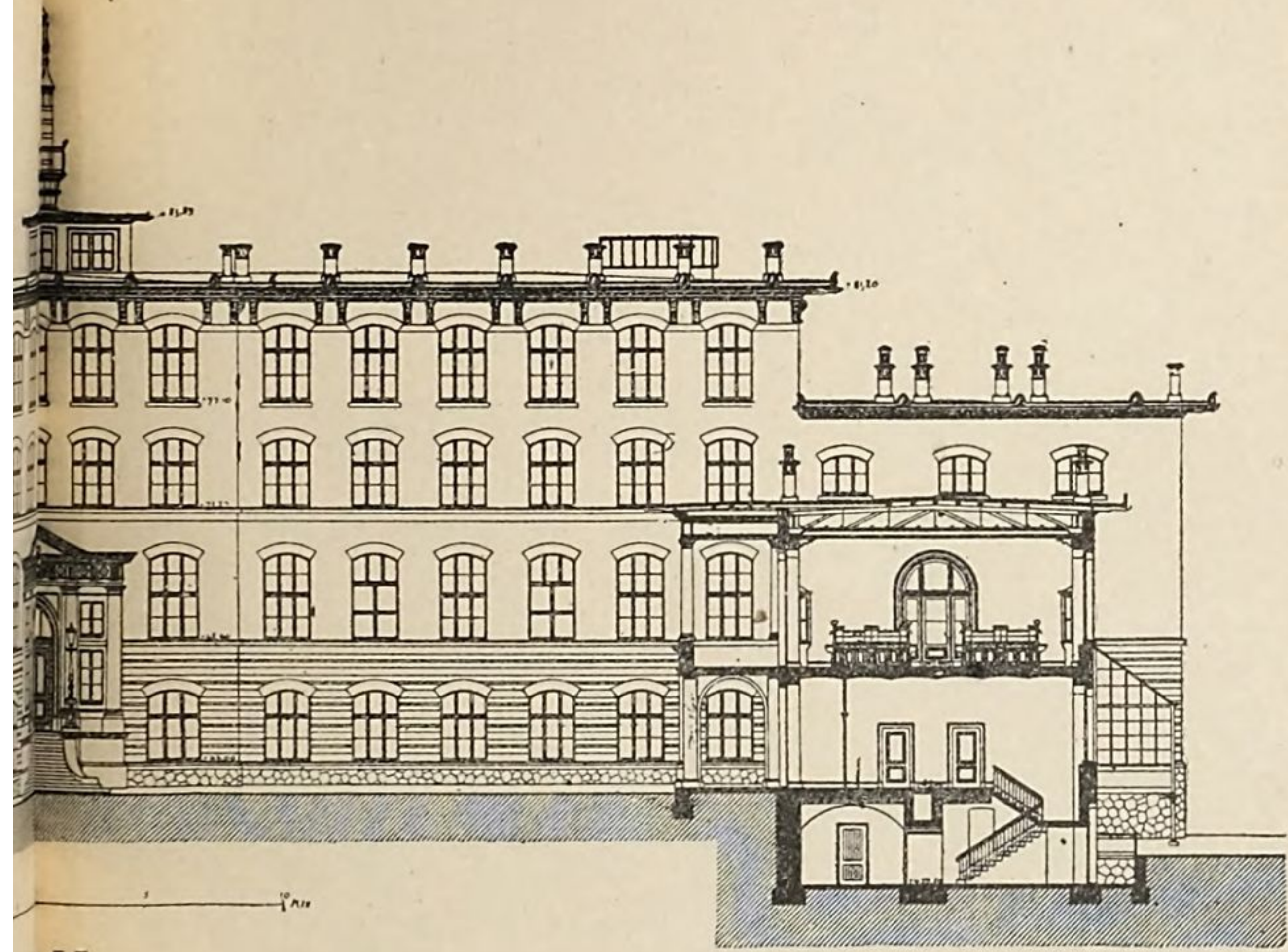
8*a.* Conference room.
9*a.* Technical lecture room.
10*a.* Apparatus room.
11*a.* Preparation room.
12*a.* Lecture specimens.
13*a.* Assistant's residence.



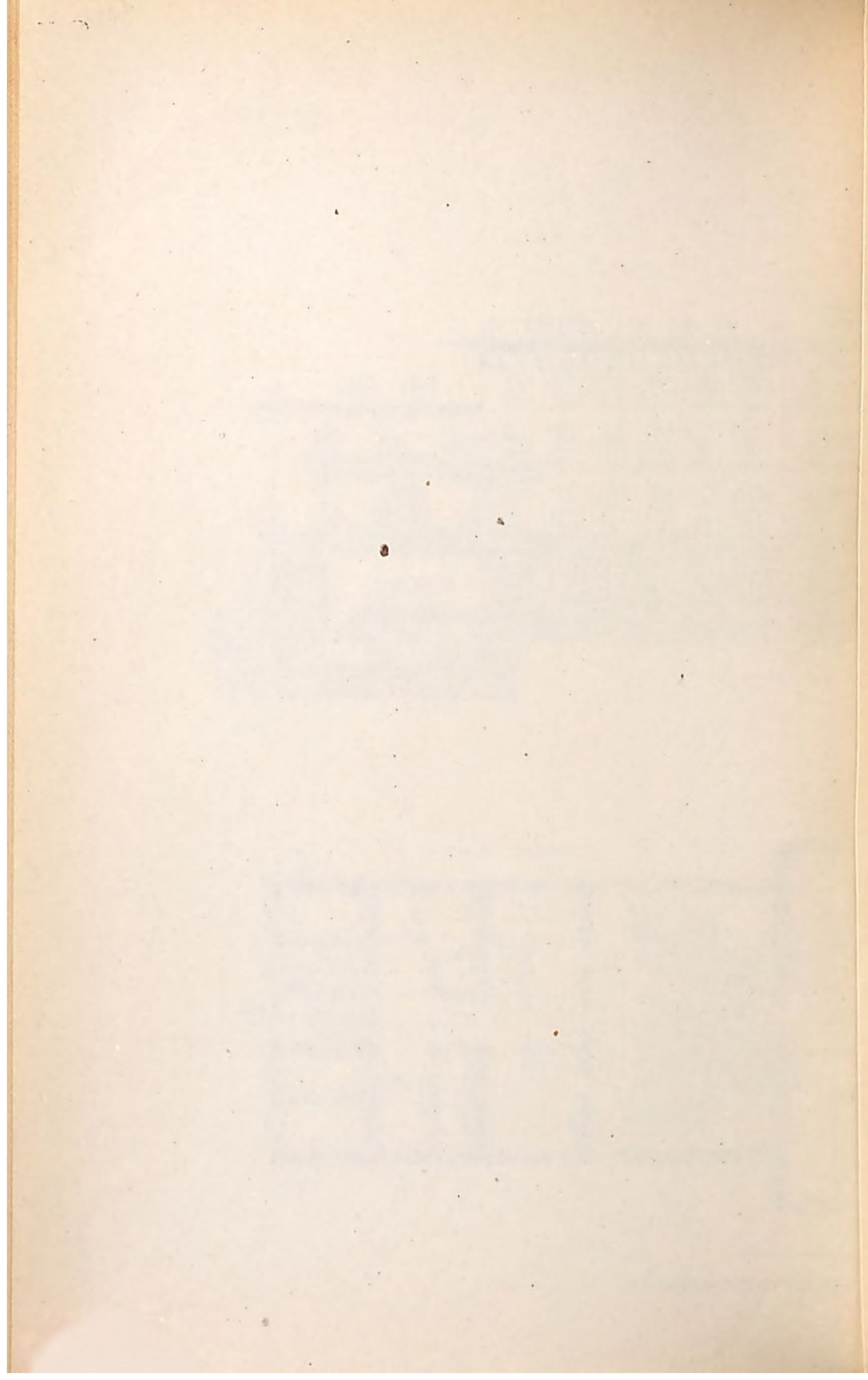
SECTION

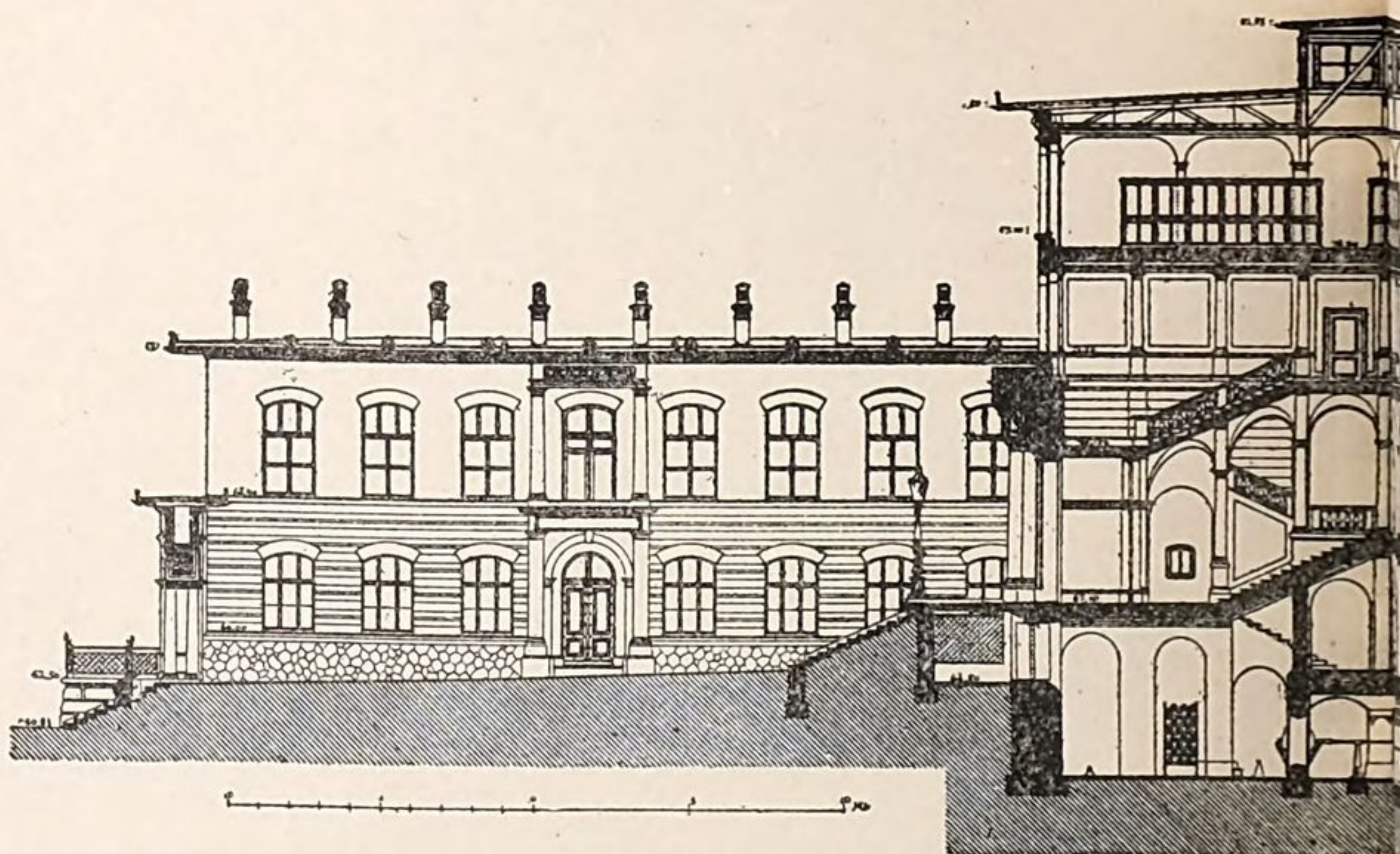


POLYTECHNIC LABORATORY, 2

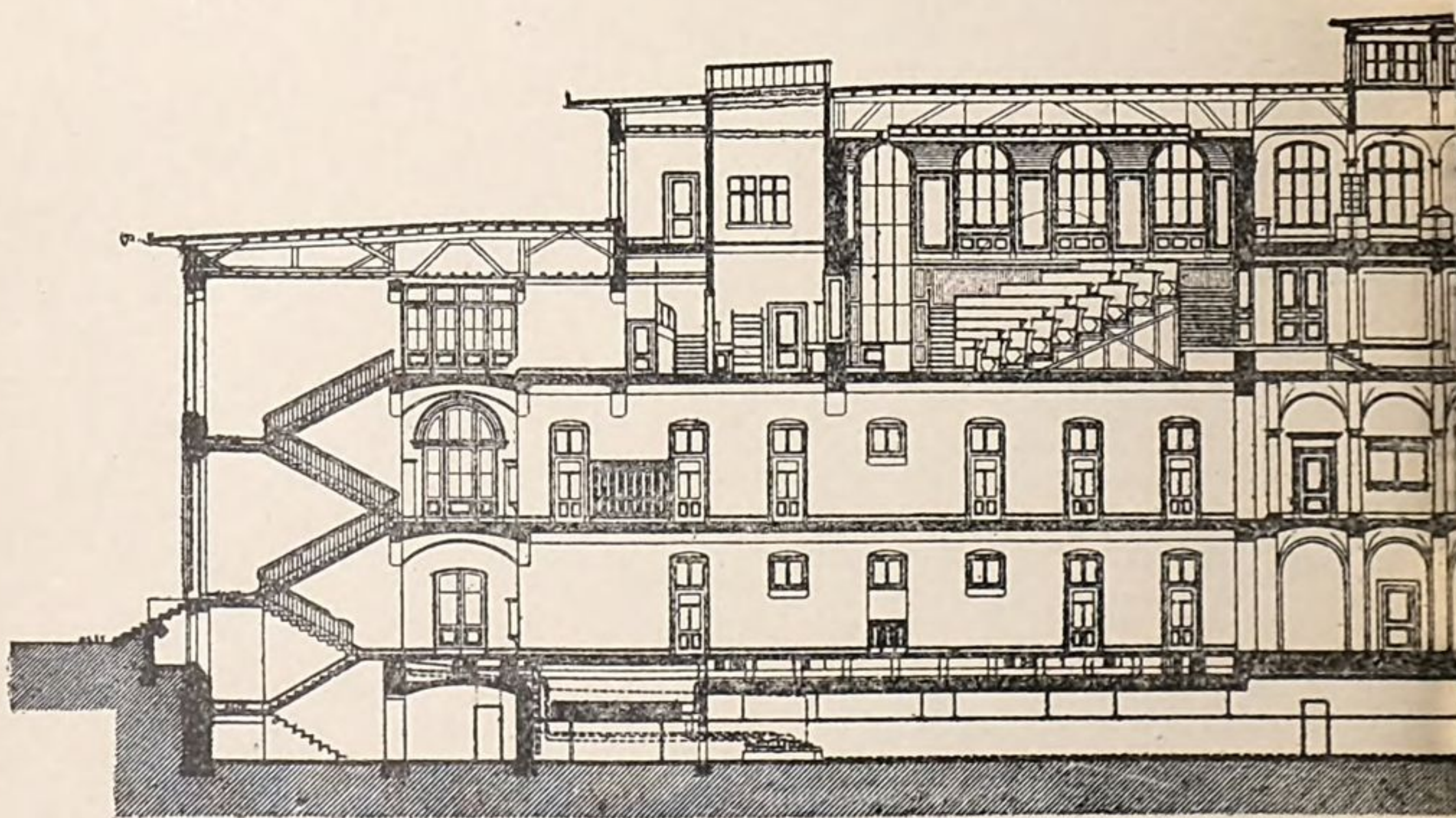


MURICH—SECOND STORY PLAN.



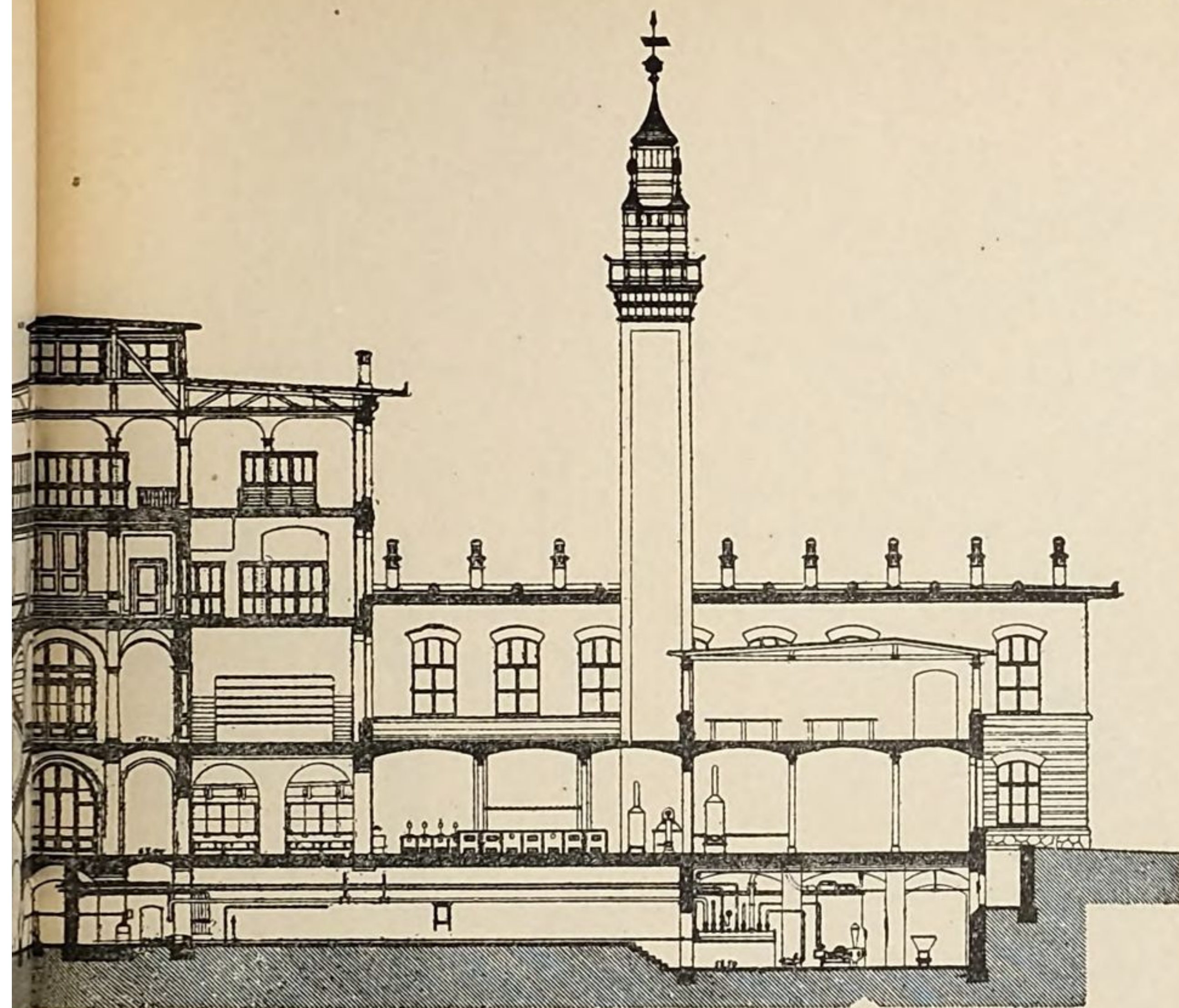


SECTION

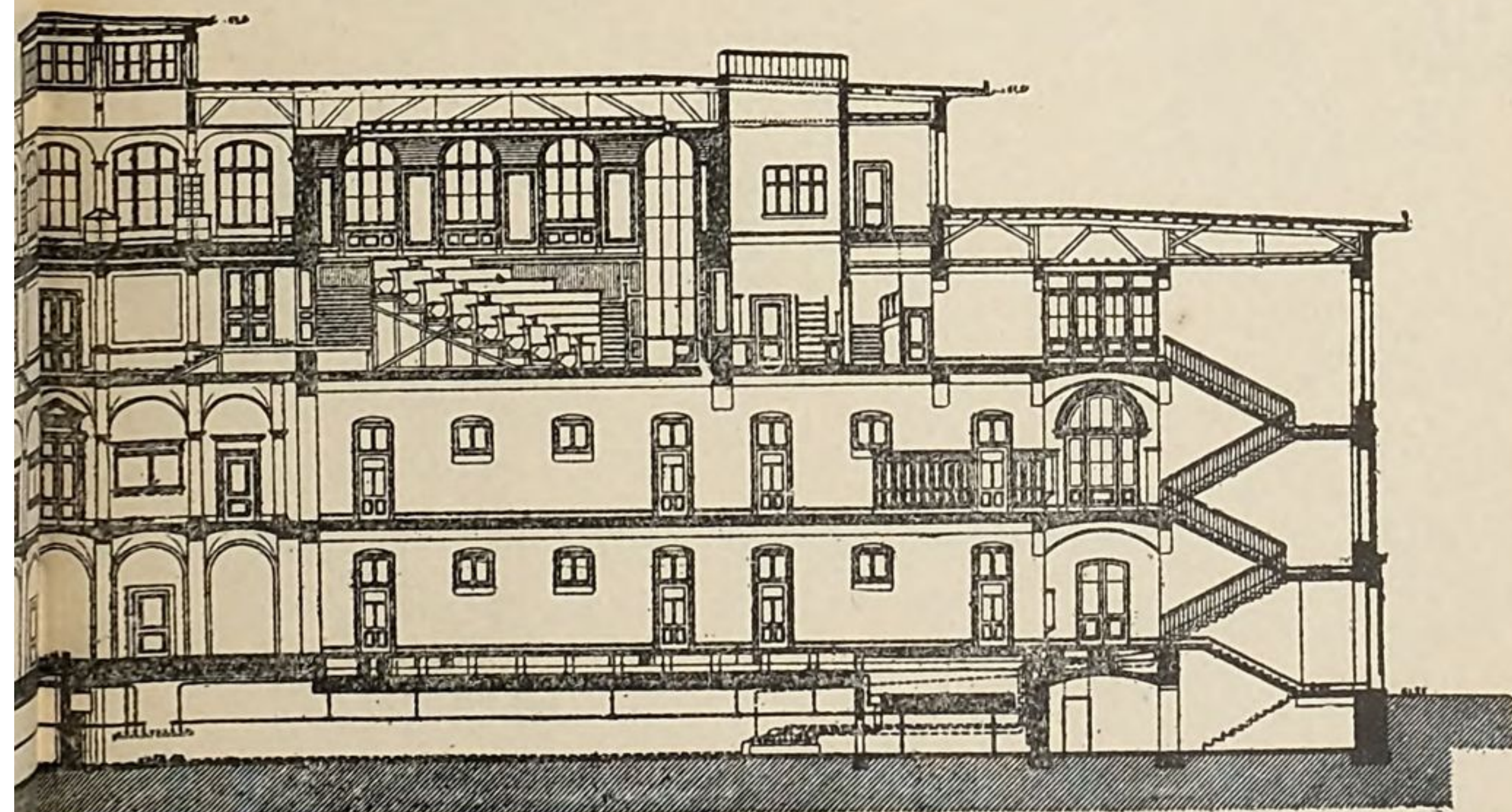


SECTION

POLYTECHNIC LAB

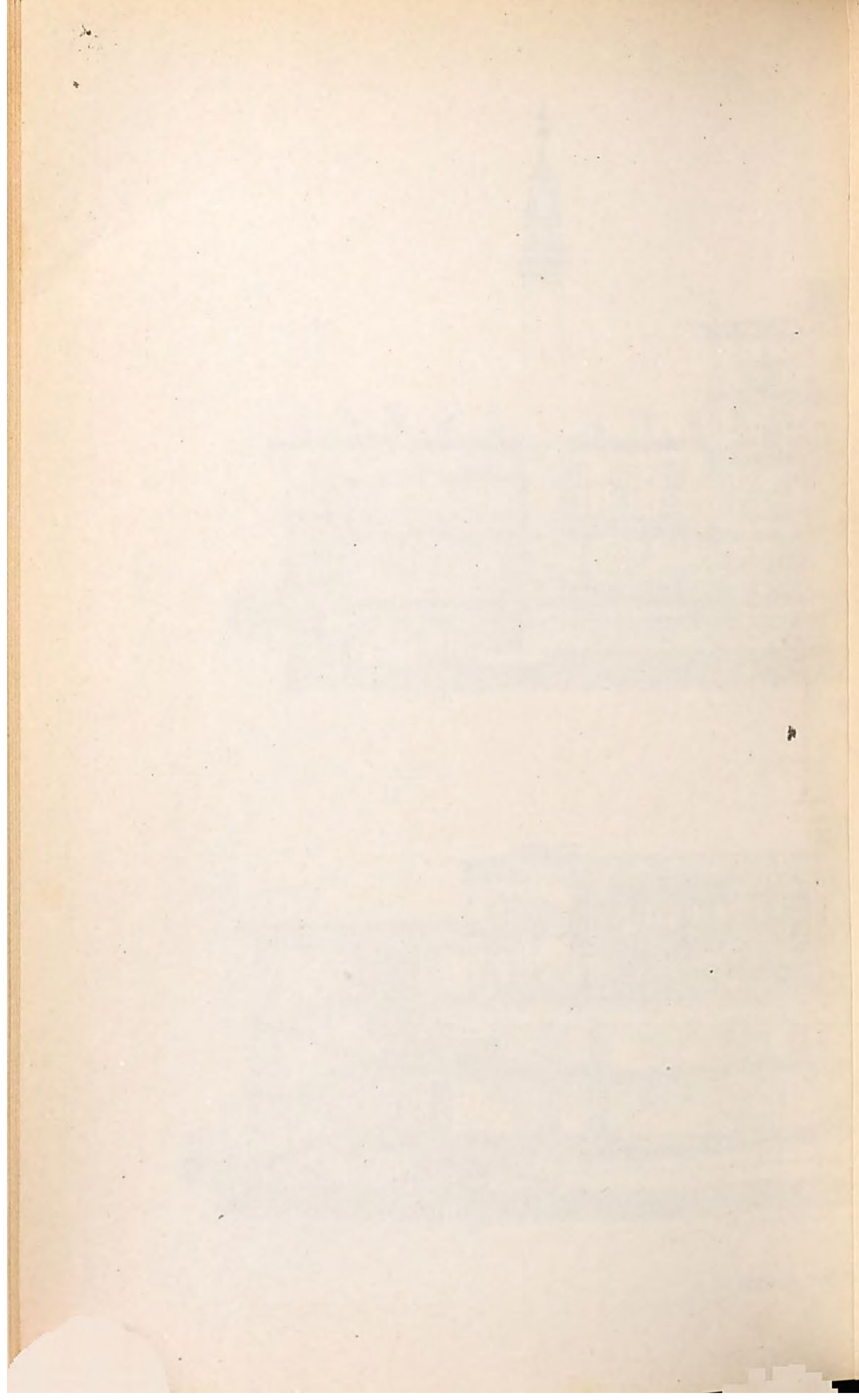


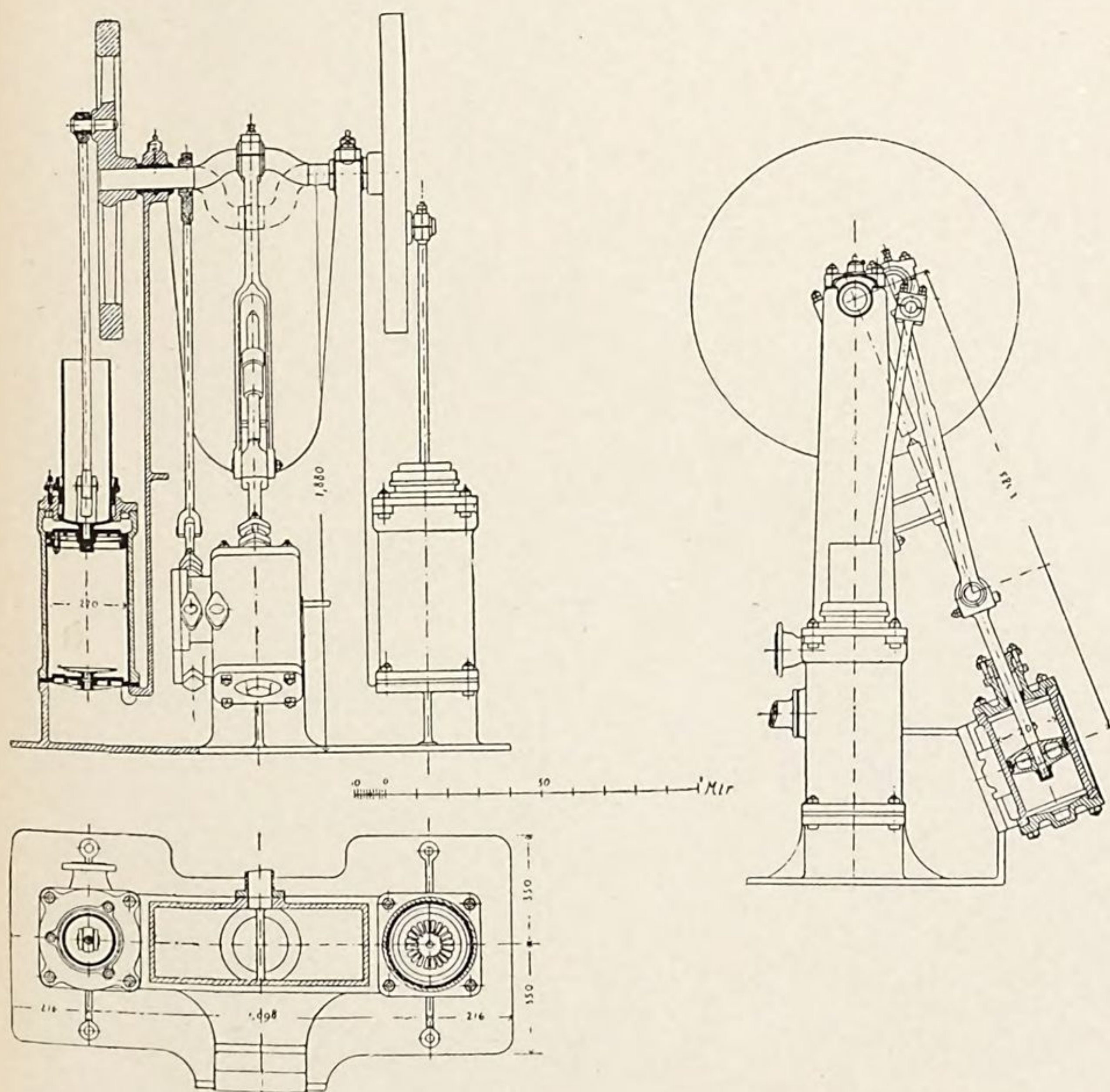
SECTION A-B



SECTION C-D

LABORATORY, ZURICH.



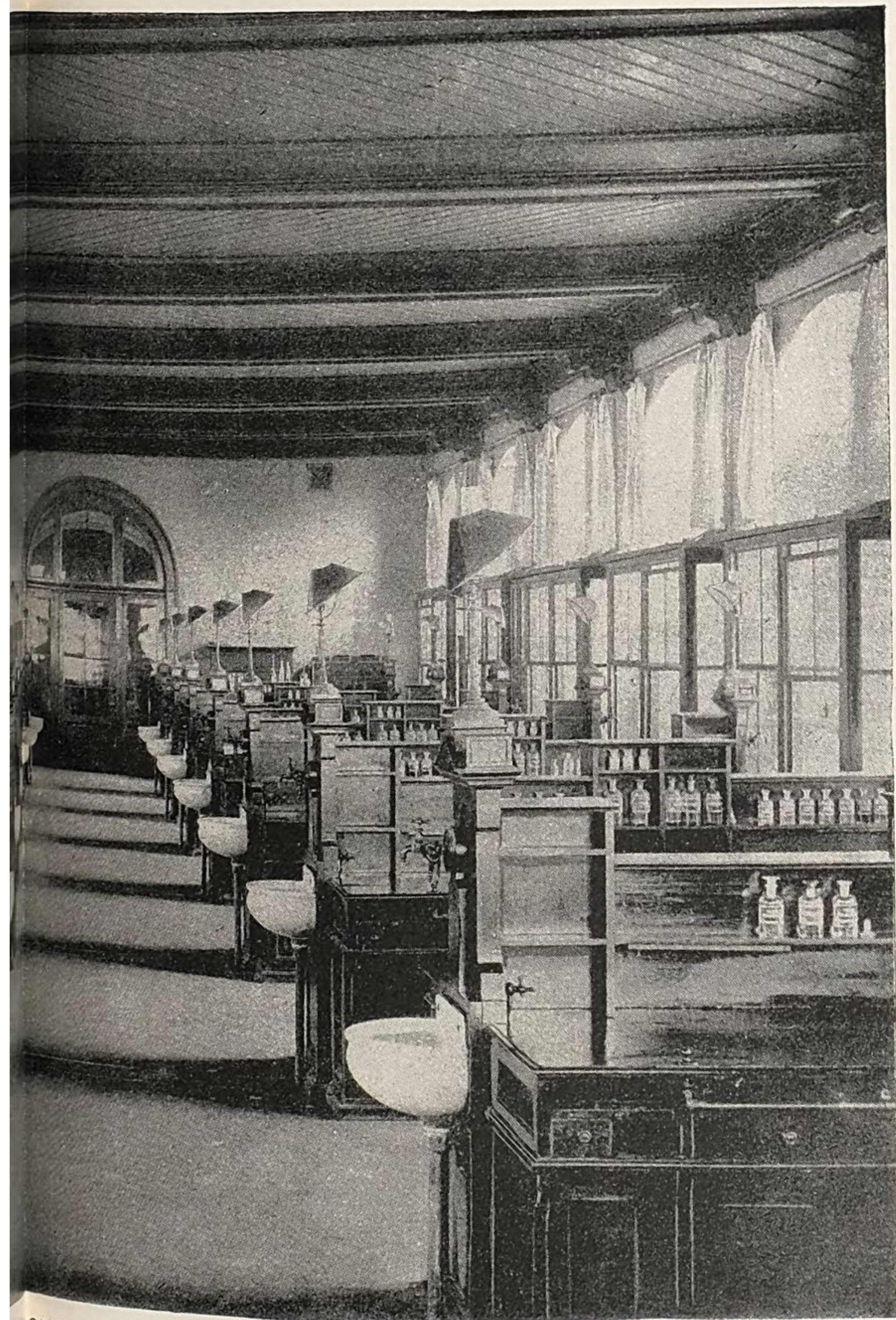


POLYTECHNIC LABORATORY, ZURICH—VACUUM PUMP.



POLYTECHNIC LABORATORY, ZURICH

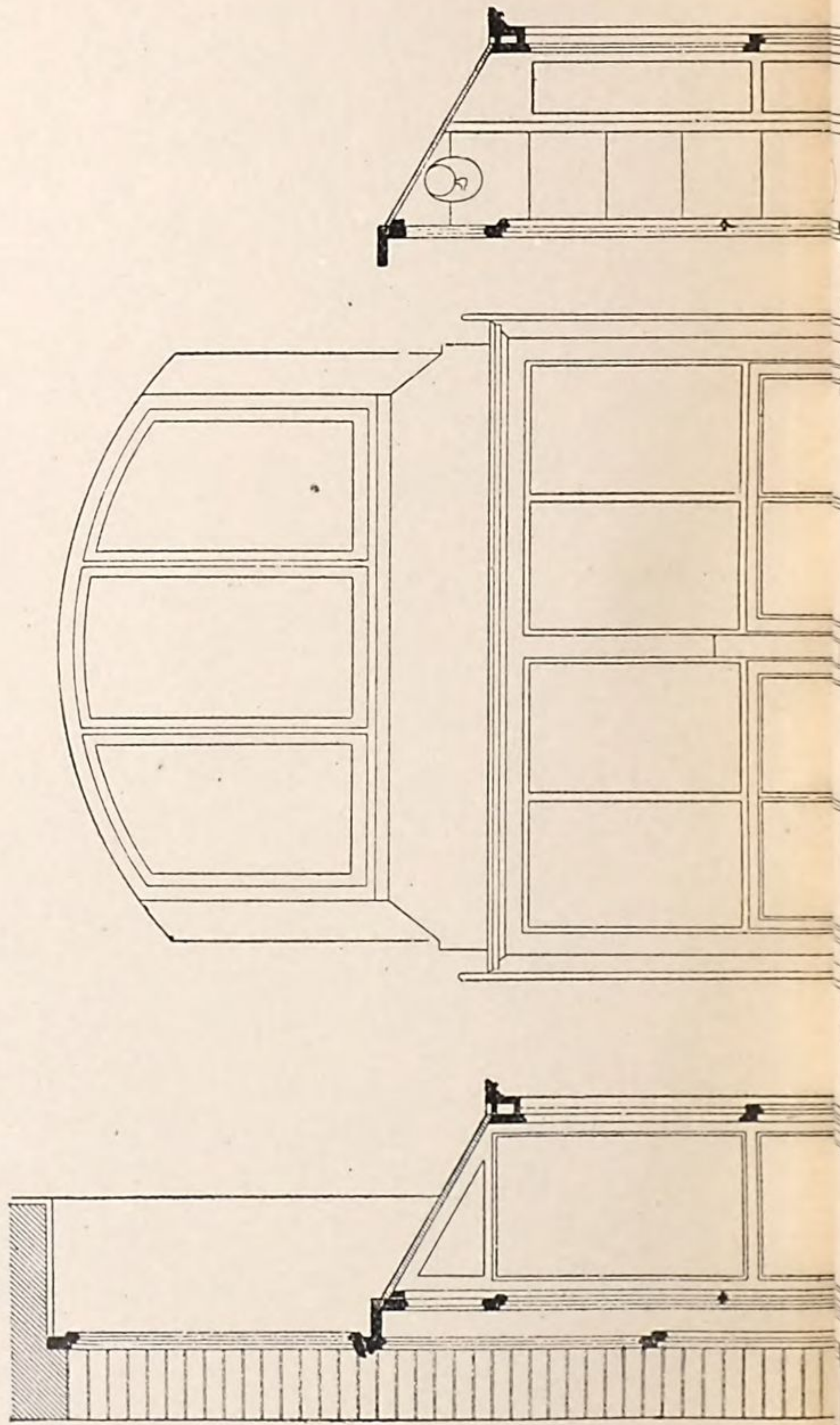
PLATE XCVIII.

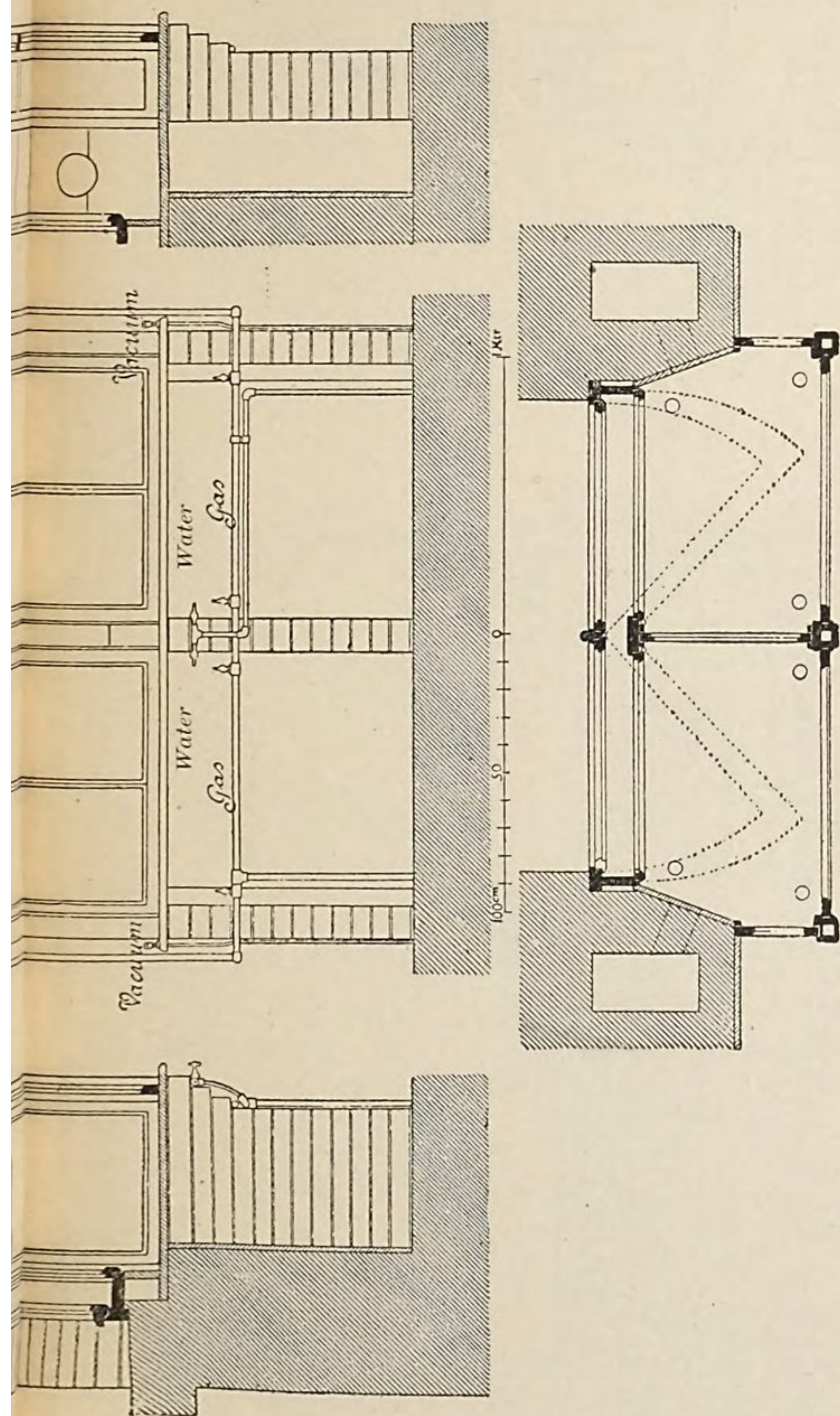


ONE OF THE LARGER LABORATORIES.

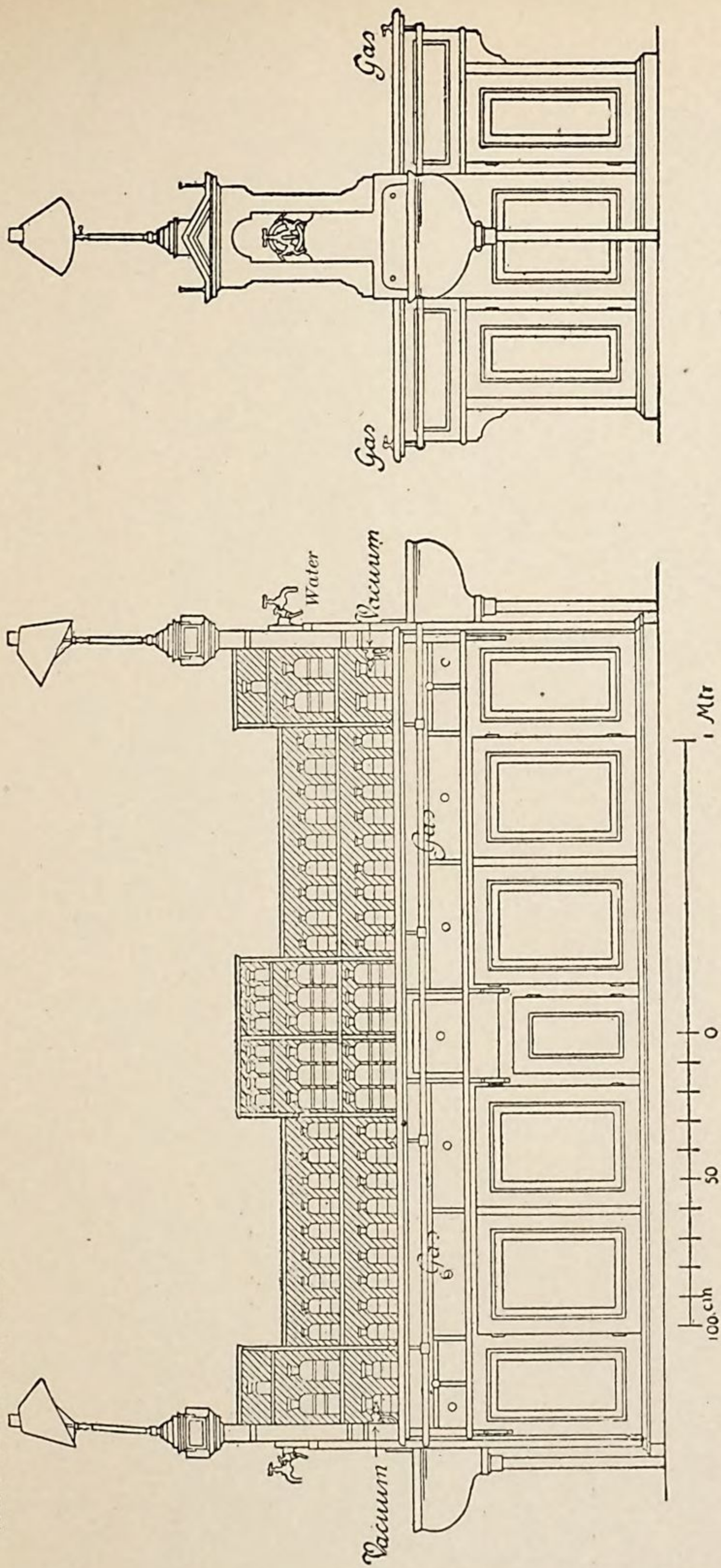
PLATE XCIX.

PARIS EXPOSITION OF 1889—VOL. 2.



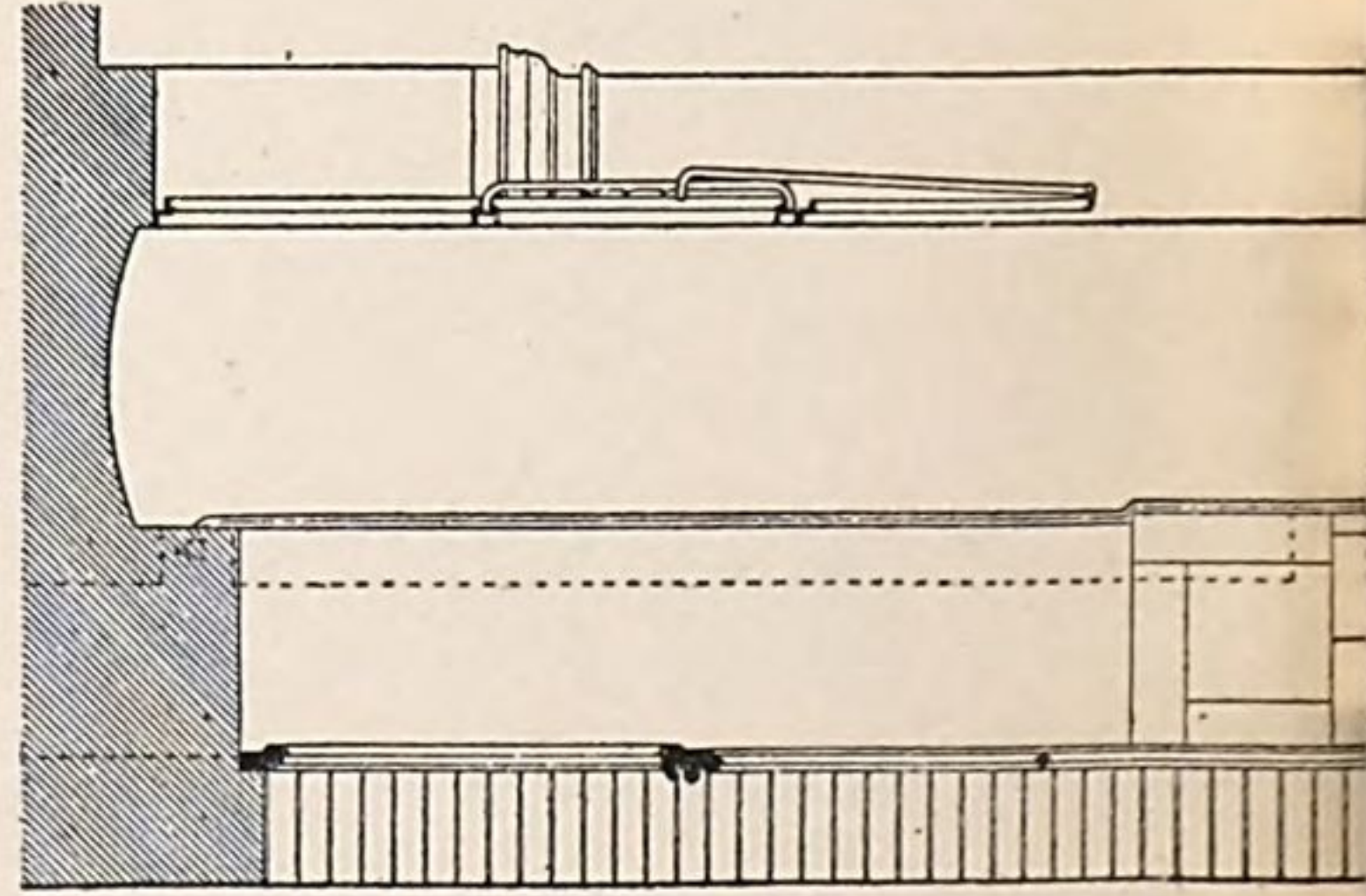


POLYTECHNIC LABORATORY, ZURICH—HOOD OF THE LARGER LABORATORIES.

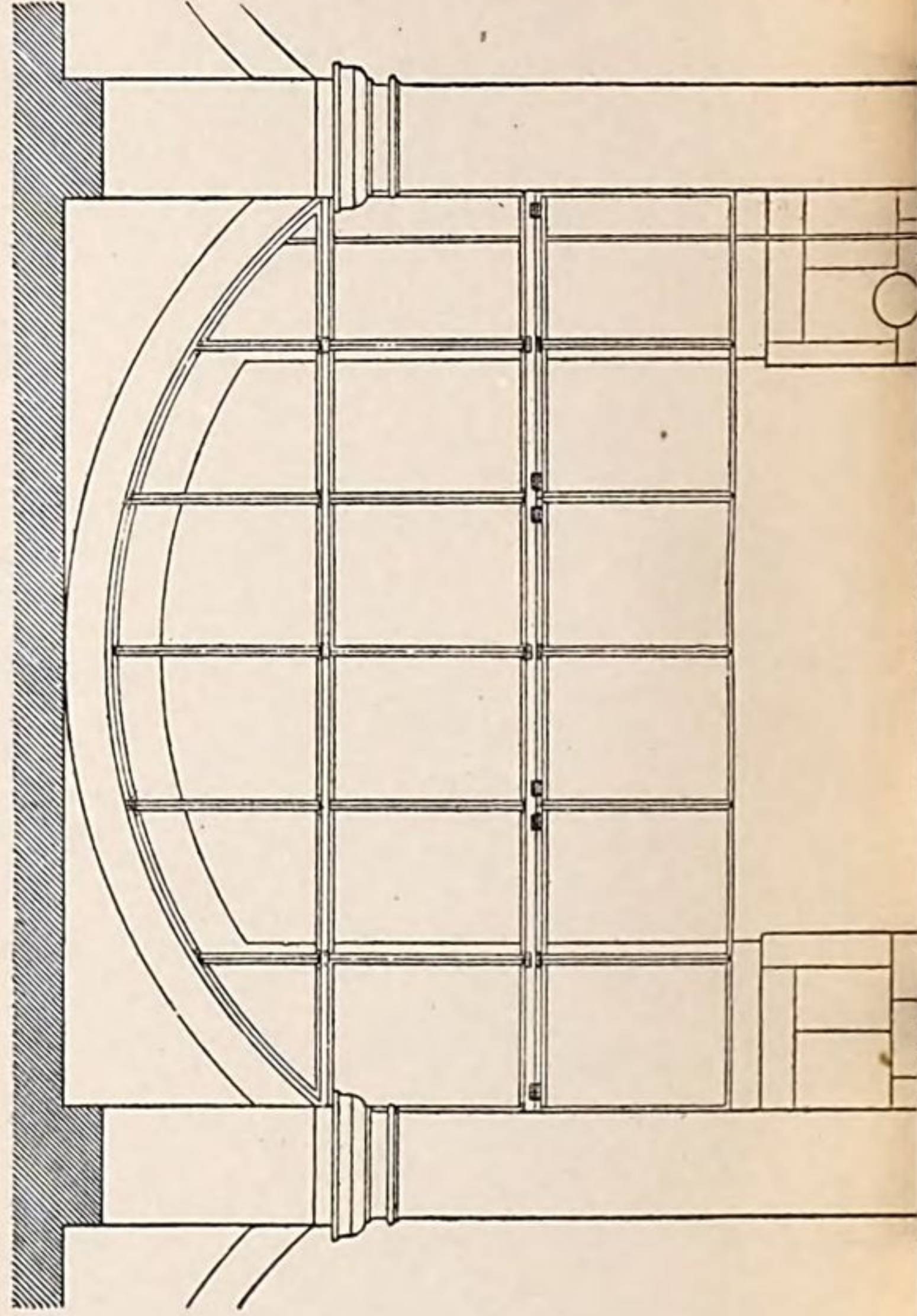


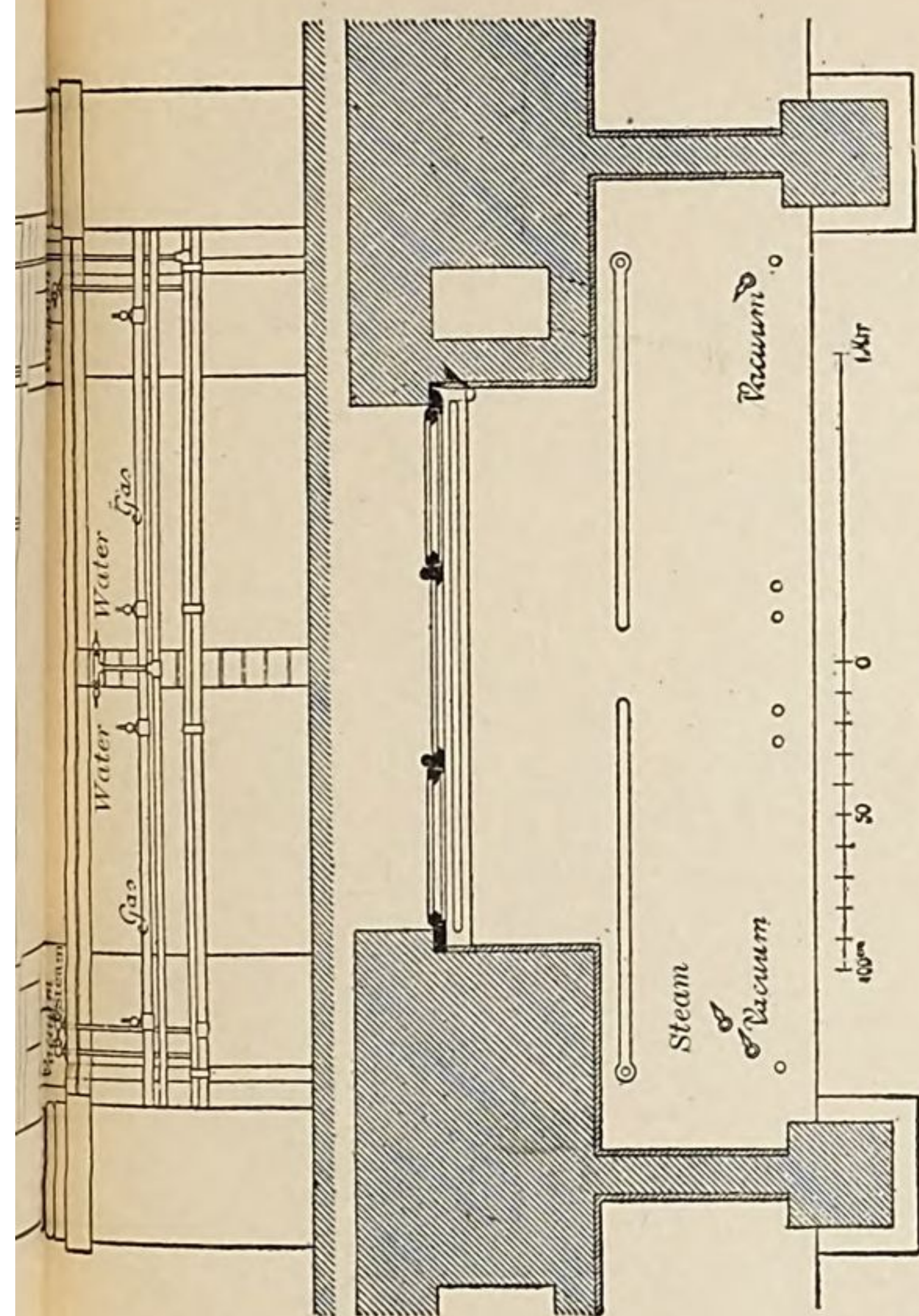
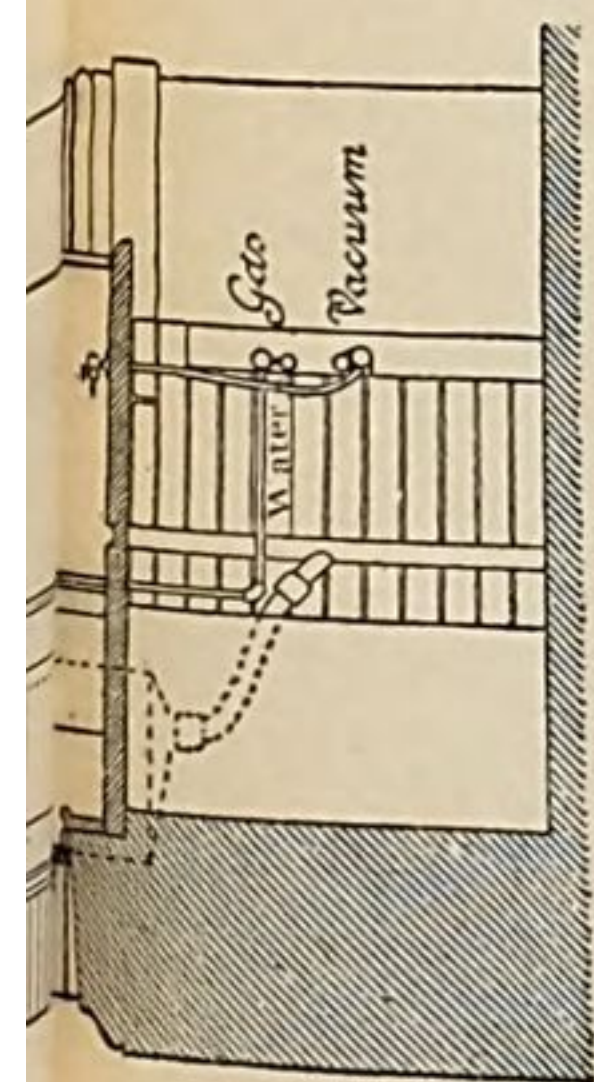
POLYTECHNIC LABORATORY, ZURICH—DESK OF LARGER LABORATORIES.

Section.

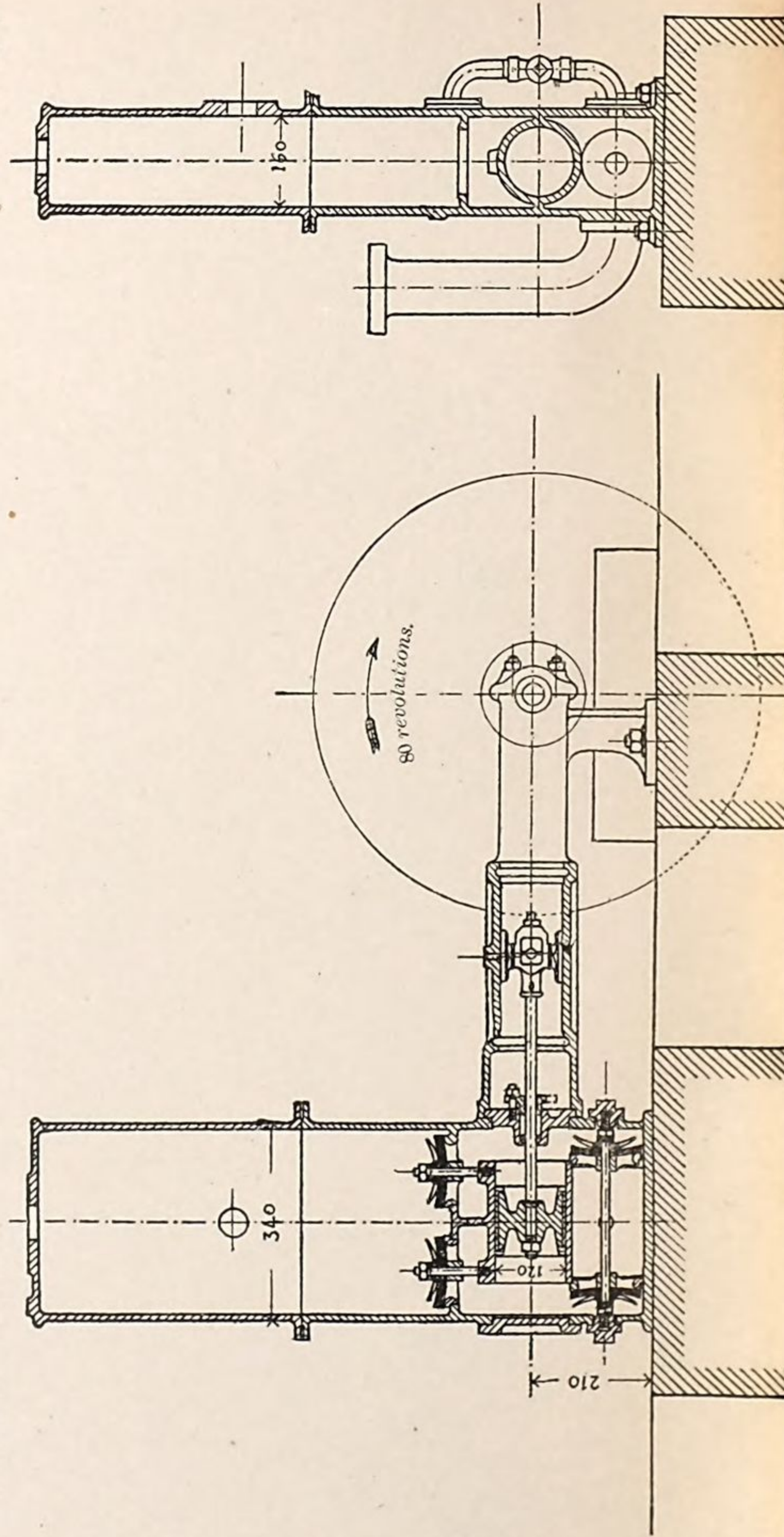


Elevation.

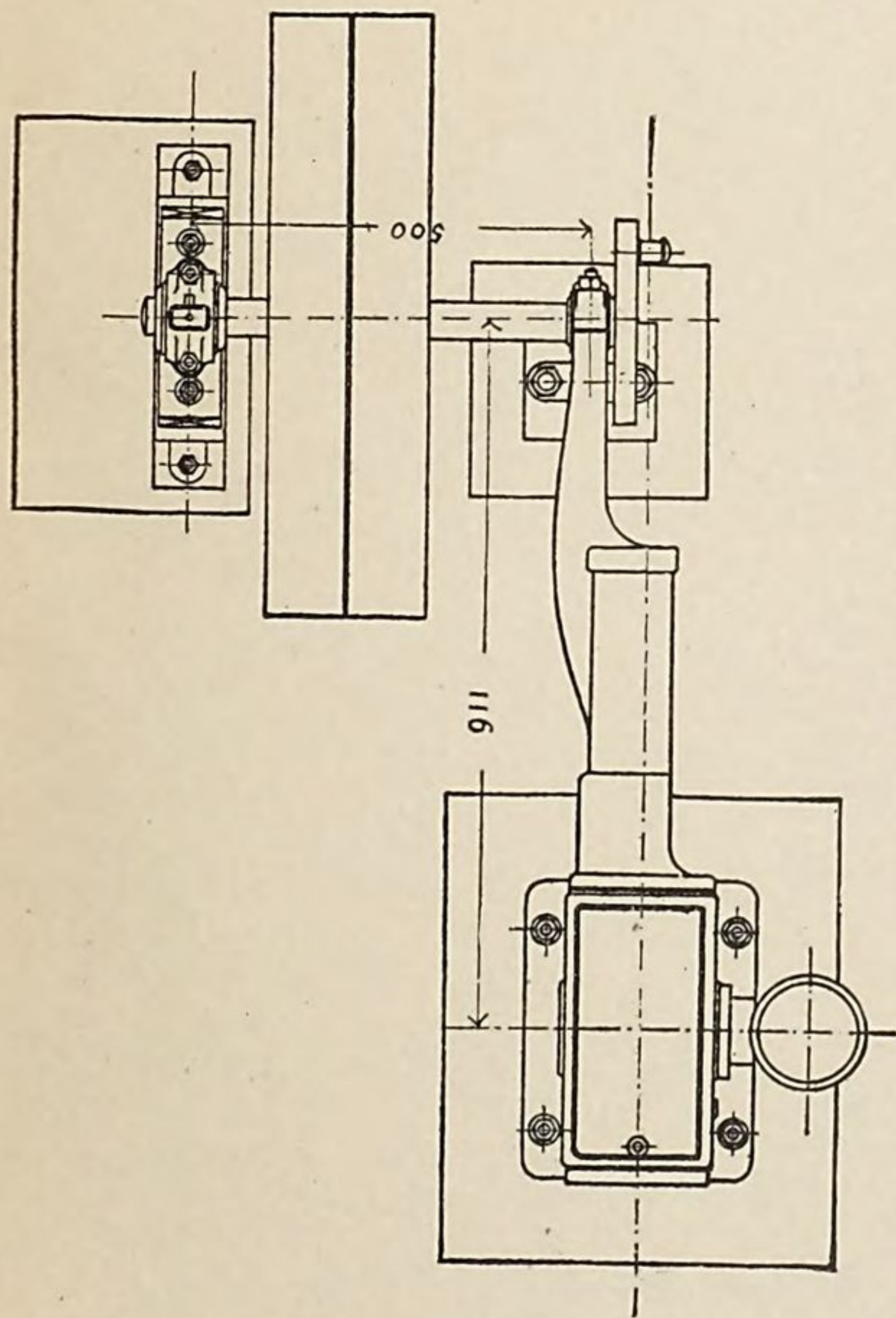




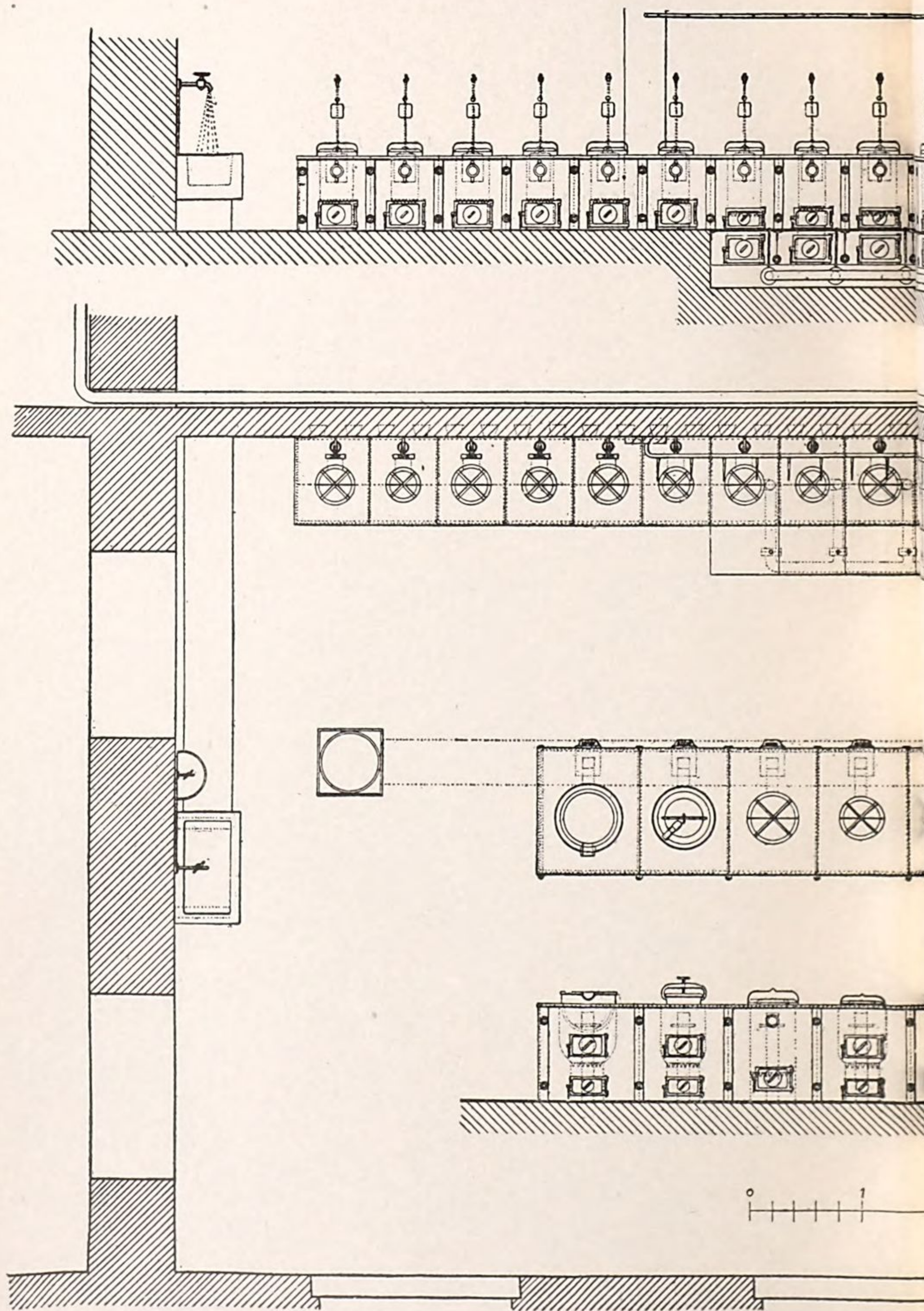
POLYTECHNIC LABORATORY, ZURICH—HOOD IN BASEMENT LABORATORY.



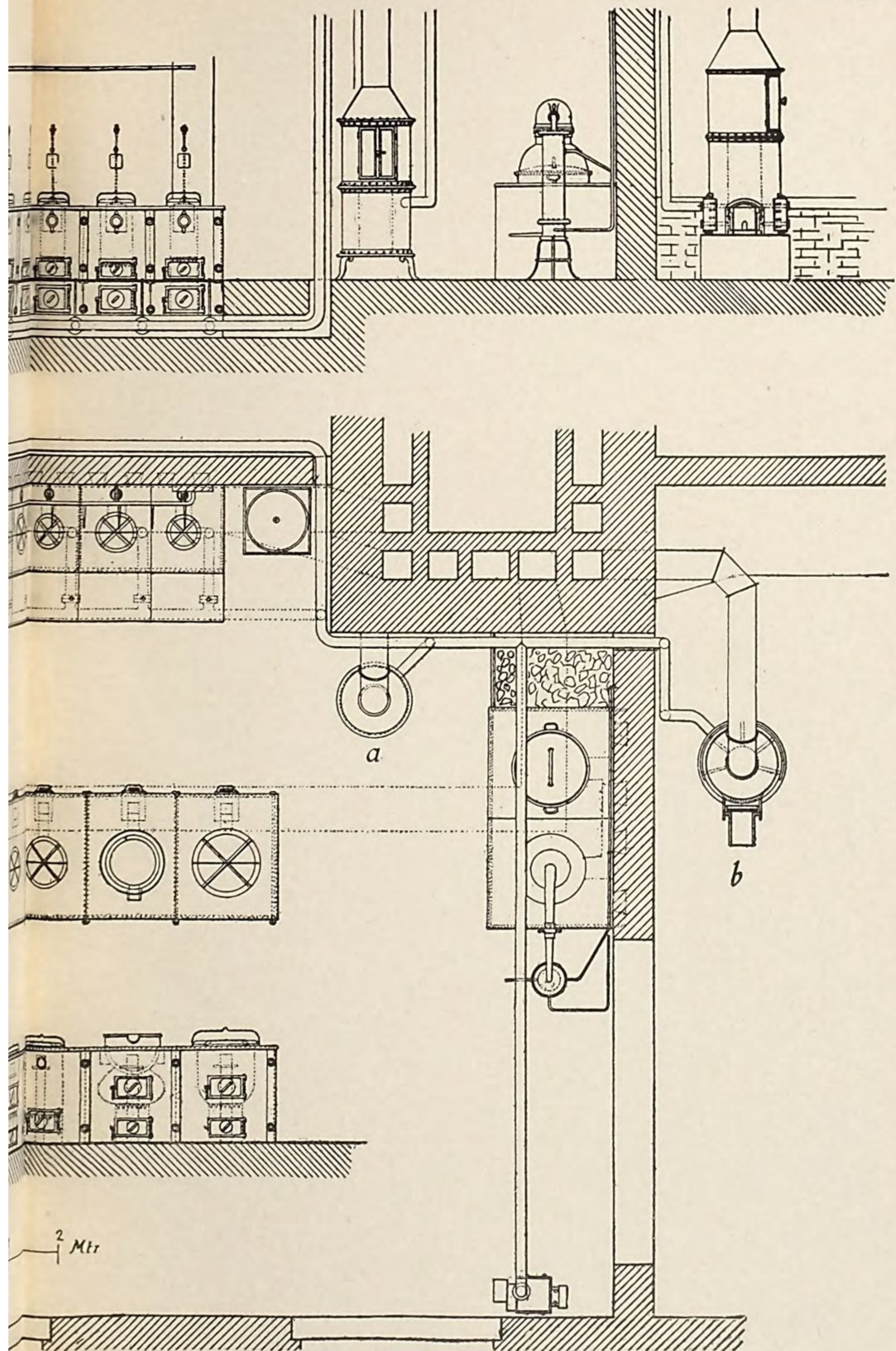
10 50 1' Mr.

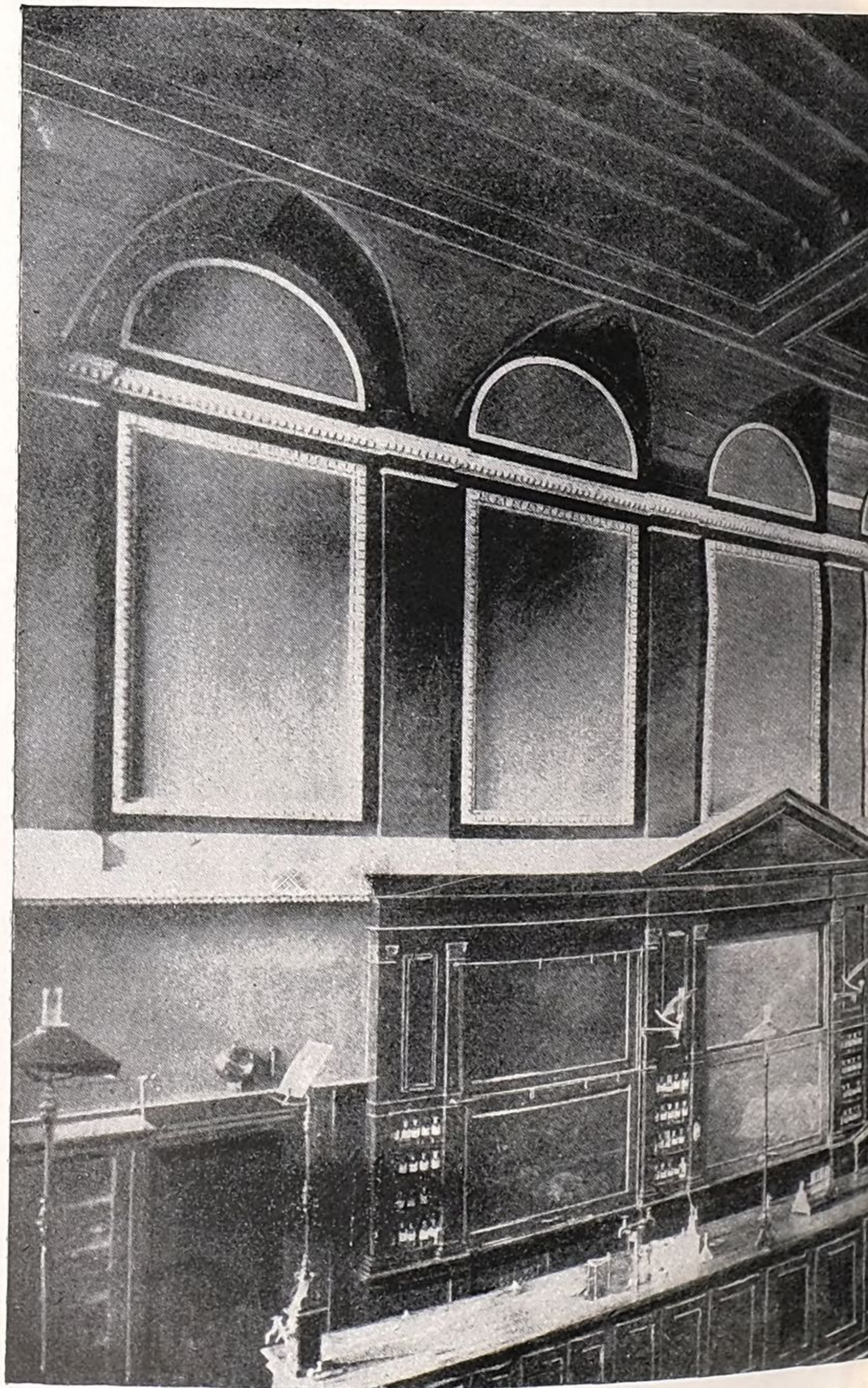


POLYTECHNIC LABORATORY, ZURICH—COMPRESSION PUMP FOR GASES.



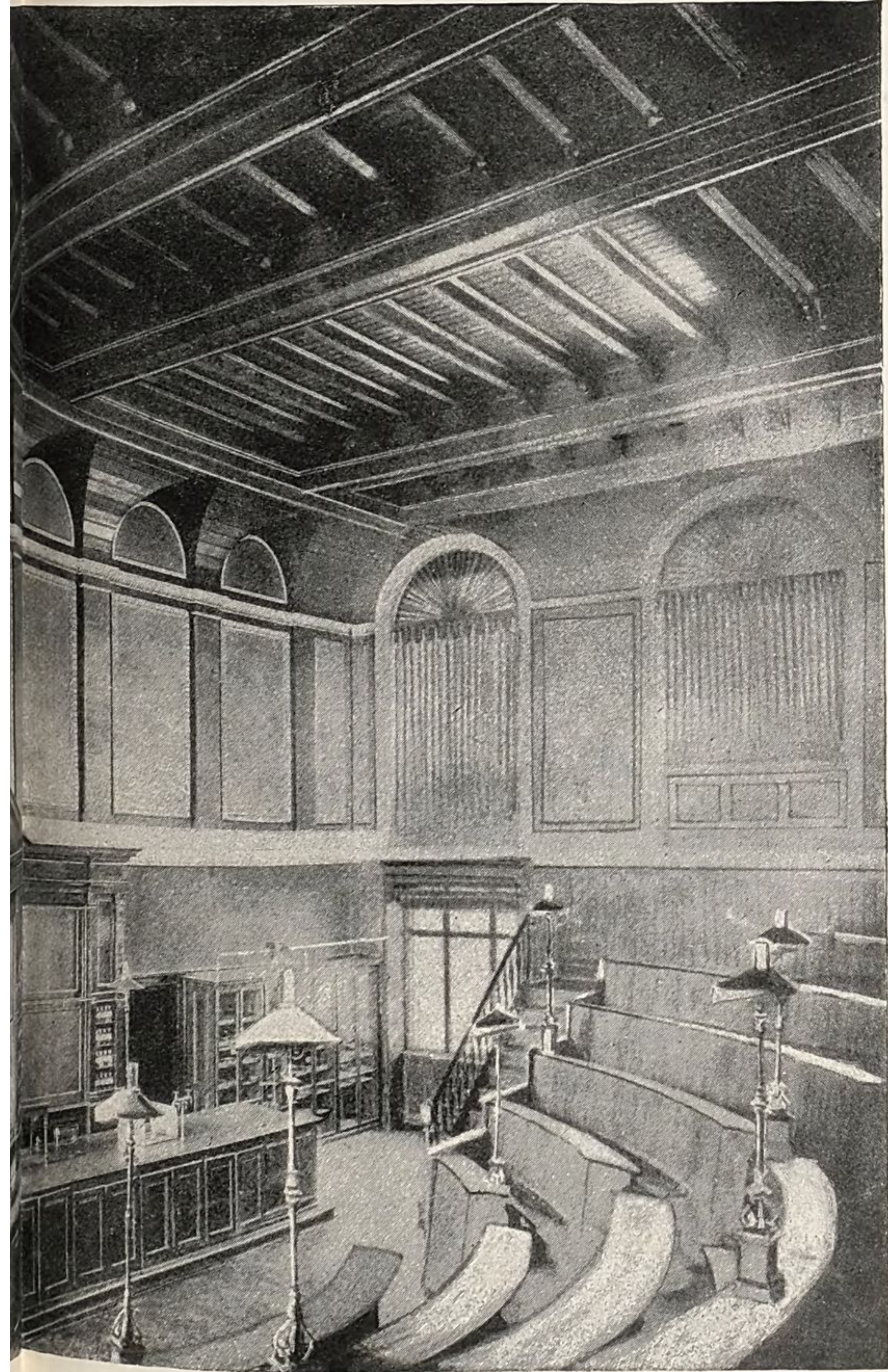
POLYTECHNIC LABORATORY, ZU





POLYTECHNIC LABORATORY, ZURICH

PLATE CIV.



ONE OF THE LARGER LECTURE HALLS.

APPLIANCES AND PRODUCTS OF METHODS EMPLOYED FOR THE PRESERVATION OF WOOD

By W. H. CHANDLER, Ph.D.

The Lehigh Valley Creosoting Company exhibited photographs and description of their works. As one of the most recently constructed establishments for this purpose, and one of the most successful, a description of them is appended, with plans and views.

An historical account of the processes employed for this purpose has been prepared under my supervision by M. D. Sohon, A. C., of Washington, District of Columbia.

THE LEHIGH VALLEY CREOSOTING WORKS, PERTH AMBOY, NEW JERSEY.

The Creosoting Works of the Lehigh Valley Railroad Company, at Perth Amboy, New Jersey, built in 1886, and at present operated by the Lehigh Valley Creosoting Company, are of interest to all parties concerned in timber constructions as emphasizing the faith that a reliable and conservative railroad management has in the economical value of creosoting, sufficient to launch out independently and construct large works on its own account.

Creosoting timber with dead oil of coal tar (creosote oil) after the proper desiccation and preparation of the timber is not a new patented process. It has been successfully in use for over 50 years. The able report of the "committee on the preservation of timber" of the American Society of Civil Engineers, says: "If the timber is to be exposed in sea water to the attacks of the *Teredo navalis* and *Limnoria terebrans* there is but one antiseptic which can be used with our present knowledge; this is creosote or dead oil. If the timber is to be exposed in a very wet situation, creosoting is also the best process to use. If the exposure is to be that of a railroad tie, creosoting is doubtless the most perfect process to use."

The process can be classed in two divisions, viz: The desiccation and preparation of the lumber for the receipt of the antiseptic and the introduction of the same. The first is accomplished by steaming

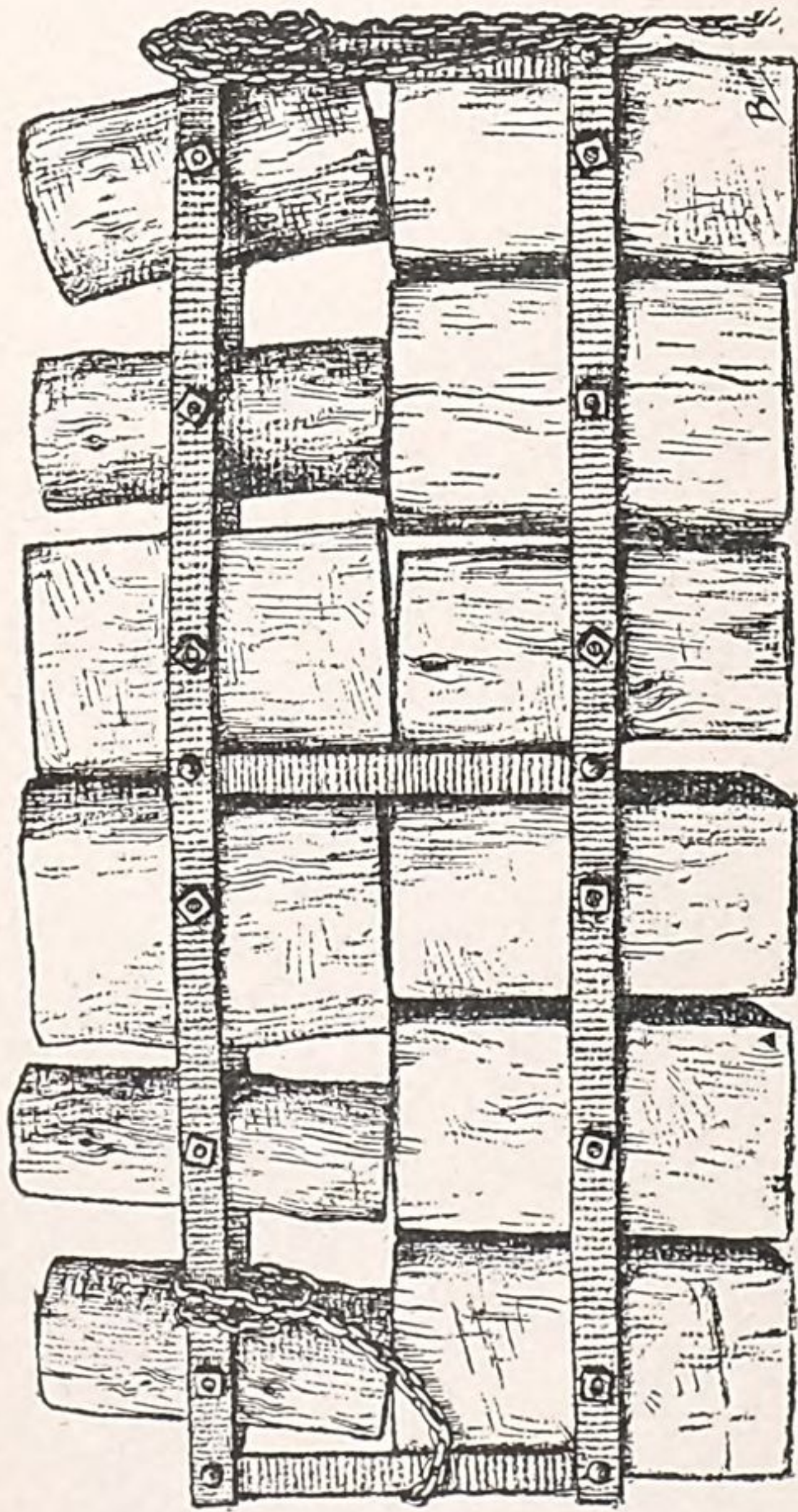
the lumber in closed cylinders with live steam and then pumping a vacuum, maintaining the heat by means of steam coils in the cylinders. When all sap and moisture are removed from the lumber, the pores opened, and the air exhausted, the hot oil is turned into the cylinders and quickly drawn up by the lumber. In some qualities of timber very little subsequent pressure is needed to get the required amount of oil into the wood, while with others, and where a large amount of oil is specified, a pressure up to 150 pounds per square inch has to be maintained for hours before the desired results are attained.

According to the quality of the wood and the use it is to be put to, the amount of oil required to be forced in is from 8 to 20 pounds per cubic foot of timber.

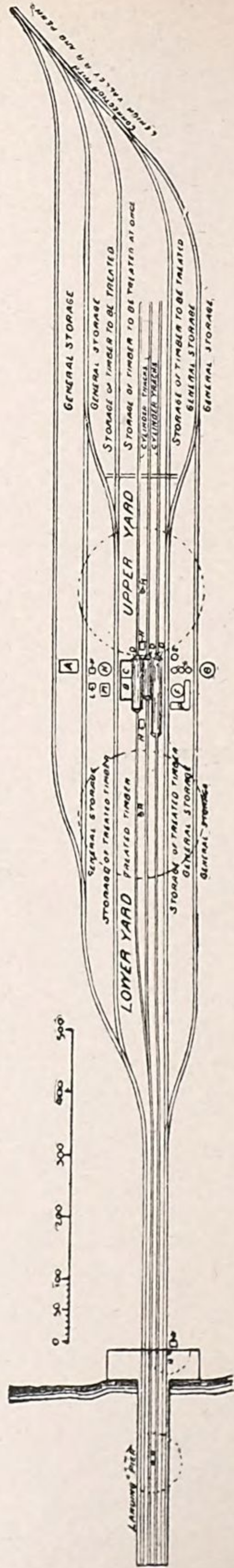
An examination of the Lehigh Valley Railroad docks at Perth Amboy, New Jersey, some years ago, and about 8 years after their first construction, made by a diver along the outside row of piles, showed about every third or fourth pile completely eaten off by the marine worm or the teredo. The foundation of the interior could not be examined by the diver for obvious reasons, but the inspection of the outside rows was sufficiently indicative of the general condition of the foundation to call for a condemnation of the whole structure, independent of the condition of the upper deck iron-work, machinery, and tracks. To reduce the thus resulting waste of materials in good condition, the extra expense of frequent renewals, and the inconvenience of throwing the dock out of service, owing to a defect in one part of the structure only, the railroad company adopted creosoting as the best preventive against the attacks of the marine worms and general decay. After several large jobs had been done by contract the company decided to build works of their own, and the result is the erection of large works equal in working capacity to any others in the country when the extensive improvements contemplated and in course of construction are completed.

The plant consists of two large steel cylinders, 6 feet in diameter, and respectively 60 and 80 feet long (with all arrangements made for the addition of a third cylinder, 120 feet long). The cylinders are open at both ends, with narrow gauge tracks running through them. There is an extensive yard at each end of the cylinders, equipped with large, double-armed derricks worked by steam winches. In addition there is the engine house with the steam, vacuum, oil, and water pumps and the boiler house with boiler and superheater. The location of the other structures, as storage tanks, working tank, receiving tank, store-house, chemical laboratory, tool house, water tank, office, landing pier, and lumber yard are shown on the plan.

The design, with cylinders open at both ends and a regularly equipped yard at the upper and lower end of the works, is believed



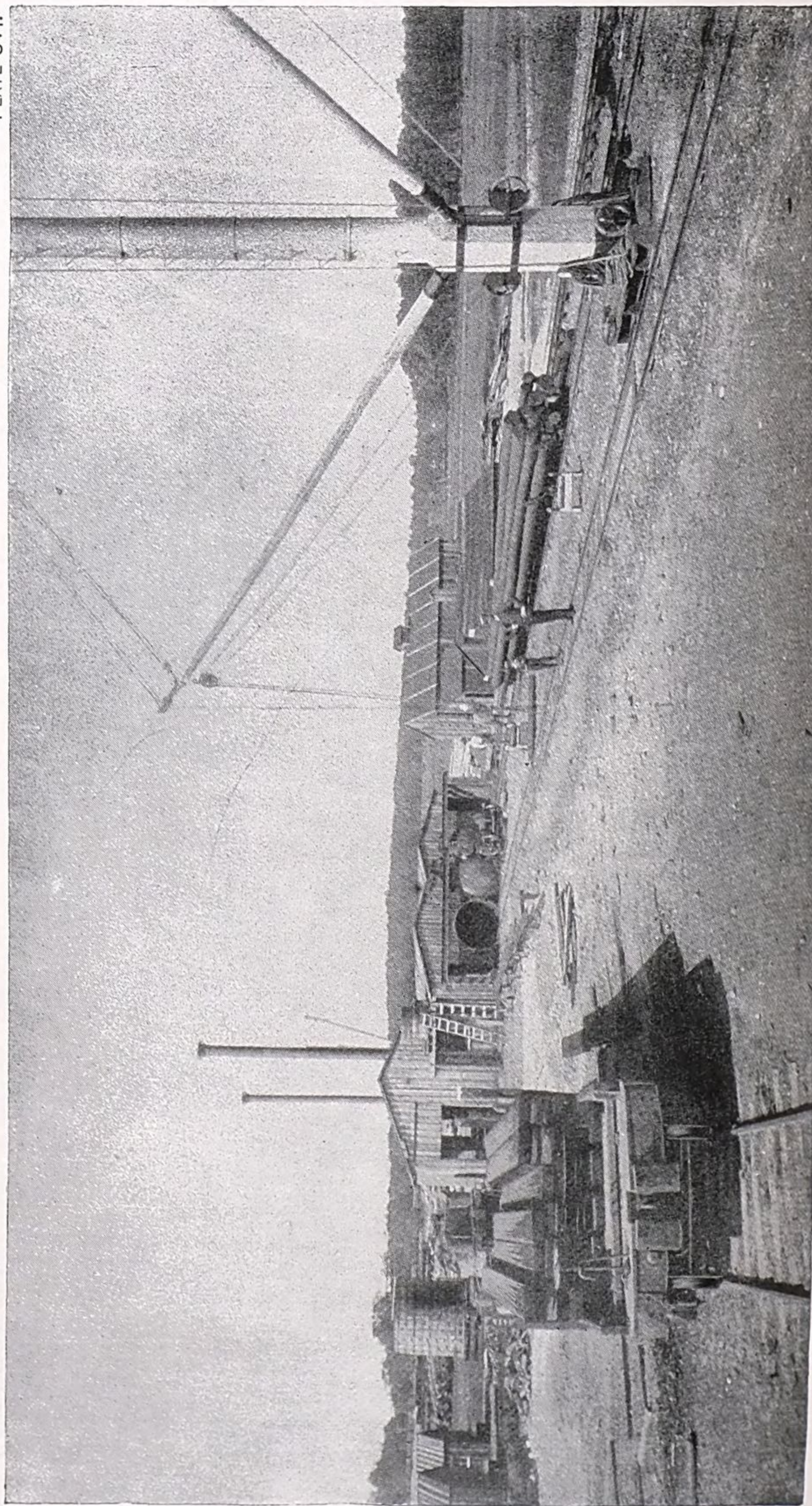
FRAME FOR IMMERSING SPECIMENS OF TIMBER.



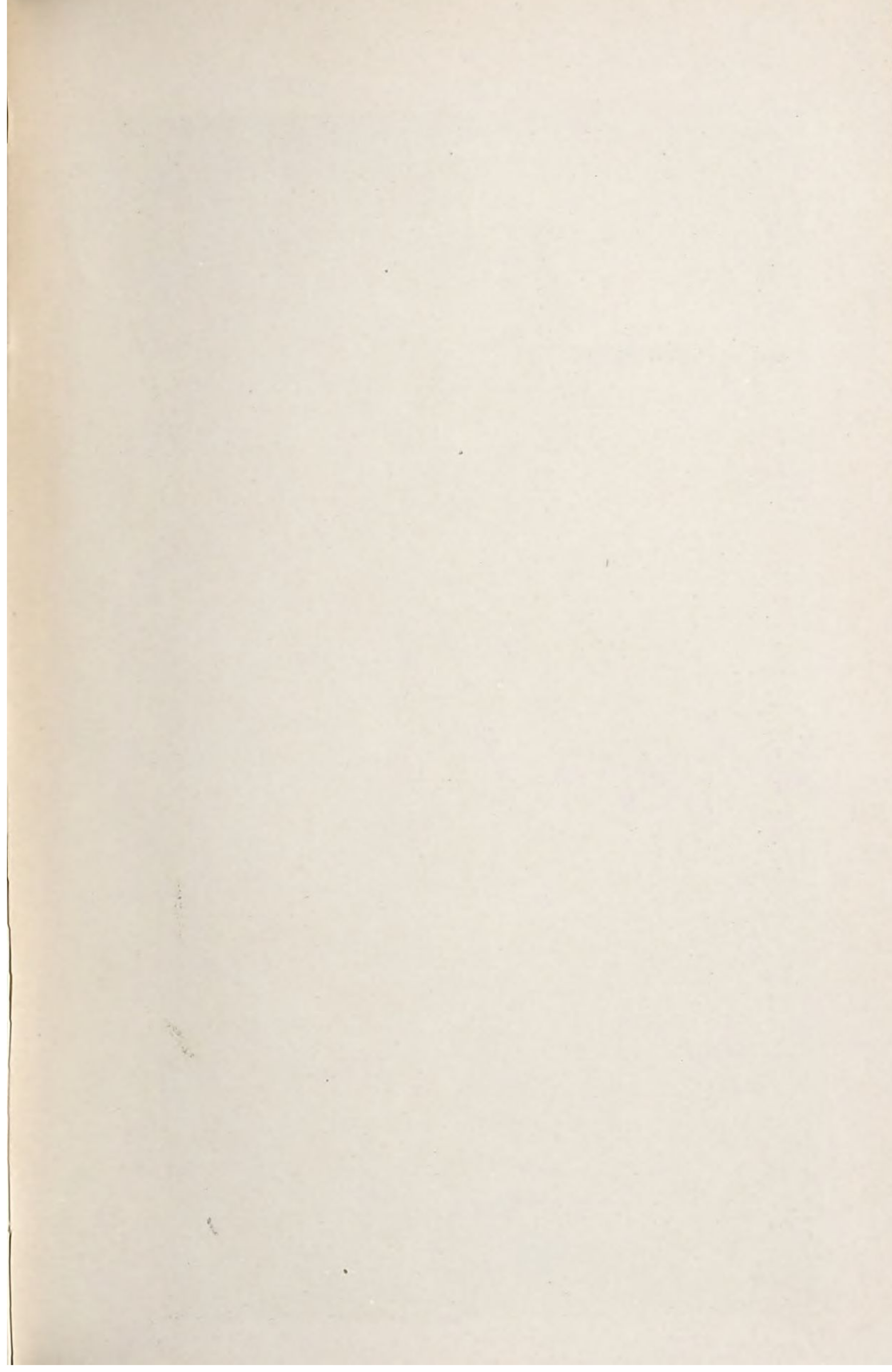
PLAN.

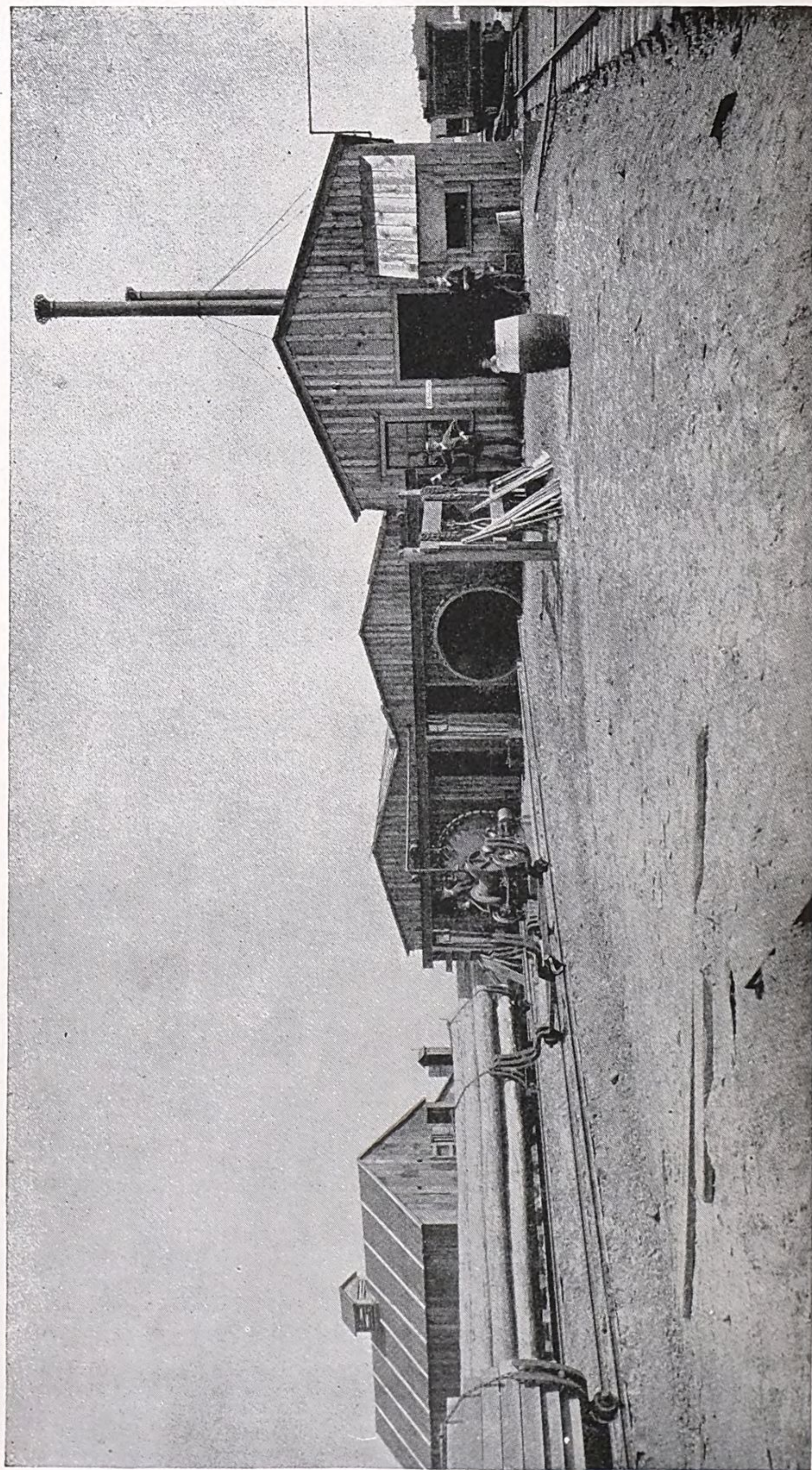
EXPLANATIONS.—A, office; B, boiler room; C, engine room; D, cylinders; E, receiving tank; F, working tank; G, storage tanks; H, water tank; K, laboratory; L, store house; M, coal bin; N, hoisting engines; P, runway for oil barrels; R, derricks.

LEHIGH VALLEY CREOSOTING WORKS.



LEHIGH VALLEY CREOSOTING WORKS, PERTH AMBOY, NEW JERSEY—FRONT VIEW.





LEHIGH VALLEY CREOSOTING WORKS—REAR VIEW.

to be an entirely new feature for timber preserving works, the usual method being to have one end of the cylinders closed permanently. A glance at the ground plan will show the convenient manner in which the railroad tracks encircle the works and run through the lumber yard to the landing pier at the water front. The general system presented offers great advantages in the handling and moving of the timber used in the process, and for shipments by rail or water. The distribution of the yard space as marked on the plan is for shipments by rail; for shipments coming from the water front the arrangement is slightly reversed.

Creosoting is of especial value in preserving the exposed timbers of coal-dumps, trestle-works, docks, telegraph poles, electric conduits, foundation timber, dikes, cribs, dry docks, dredges, ships bottoms, paving blocks, fence posts, cross-ties, bridges, breakwaters, bulkheads, etc.

The timbers of those parts of a dock or structure should in all cases be creosoted which, if decayed or eaten by the teredo, would cause serious delays to traffic until repairs were completed, or which, if defective, would cause good parts of the structure or building to be torn down in order to make the necessary repairs to the defective parts.

The number of men employed by the Lehigh Valley Creosoting Company is about thirty. The capacity per month is 400,000 feet board measure. The works have creosoted, since they started in 1887, about 3,000,000 feet board measure square lumber, 1,000,000 linear feet piling, 60 miles underground conduits, besides a large number of cross-ties and lumber for miscellaneous purposes (1889).

The works were built by the Lehigh Valley Railroad Company, under the supervision of A. W. Stedman, chief engineer, and Walter G. Berg, assistant engineer, and are operated by the Lehigh Valley Creosoting Company, H. Stanley Goodwin, president, and Walter G. Berg, superintendent.

[From the Engineering News, September 1, 1888.]

WOOD TREATMENT TESTS.

In order to ascertain the relative life and value of wood treated with various antiseptics in comparison with untreated lumber, and the relative resistance of different kinds of timber and treatment processes to the ravages of the teredo, Mr. A. W. Stedman, chief engineer of the Lehigh Valley Railroad Company, has had a series of tests made at Perth Amboy, New Jersey, and the results of these experiments, as found in the report of Mr. Louis Focht, engineer in charge of the works, are here given.

Seventy-five specimens of wood were sunk in four iron frames, arranged as shown in the figure, in sea water at Perth Amboy, on March 29, 1887, and they were drawn up and examined on April 30, 1888, after 13 months' immersion.

The frames were about 20 feet apart, two containing the untreated and two the treated lumber. The specimens were full-sized pieces of piles, cross-ties, and square dock lumber, each piece about 2 feet long. The following kinds of timber were experimented upon: White oak, red oak, tamarack, white cedar, spruce pine pile, yellow pine pile, chestnut, cypress, spruce pine pile peeled and with the bark on. The antiseptics used were coal tar, creosote or dead oil of coal tar, fernoline or wood creosote, and coal oil residuum.

The general summary as given in Mr. Focht's report stands as follows:

"The specimens enumerated above have been exposed to the action of the teredo for nearly 13 months; the place where they were sunk is fully as exposed as any locality in the vicinity of the docks; the frames were all exposed to about the same influences, they being sunk about 20 feet apart.

"The examination of the untreated timber seems to indicate that the teredo has a preference for the softer kinds of wood. The white cedar, tamarack, cypress, and spruce in all cases containing more worms than the oak, chestnut, and yellow pine. The yellow pine specimens were noticeably free of worms; this may be due to the pitch contained in the wood.

"There was an untreated piece of cypress pile (No. 66) sunk with frame No. 2. This pile, upon examination, was found to contain a large number of worms. The claim that the teredo will not attack a cypress pile can not therefore be taken as general.

"There were thirty-one specimens of different kinds of wood treated with 'dead oil of coal-tar creosote' exposed. A thorough examination of every piece failed to reveal any evidence of the presence of the teredo.

"The teredo, with but one exception, attacked the timber treated with 'coal oil residuum.' There were three specimens exposed, and two of these were found to contain a large number of worms, one of them being eaten worse than any piece of timber in the whole lot. The thick parts of the oil, which adhered to the surface of the wood when the frames were sunk, were found to be partly washed off, but the wood was still impregnated with the oil. The presence of this 'residuum oil' did not appear to prevent the teredo from entering, as the parts of the wood containing the oil were eaten entirely through.

"Frames Nos. 1 and 3 contained besides the specimens treated with the 'dead oil of coal-tar creosote' and 'coal oil residuum' three pieces of yellow pine piles treated with 'fernoline oil' (or wood creosote), two of these were found to be sound; but specimen No., 52 in frame No. 1, was found to contain three large well-developed worms about the size of a lead pencil. The 'fernoline oil' (or wood creosote) was not washed out of the wood in either case; for by boring in with a small auger the oil was found to have penetrated to a depth of $2\frac{1}{2}$ inches below the surface.

"After the inspection the frames were all carefully replaced in their previous positions."

GENERAL SUMMARY.

Kind of timber.	Treated with creosote oil (dead oil of coal tar.			Treated with ferroline oil or wood creosote.			Treated with coal oil residuum.			Untreated.		
	No. of specimens exposed.	No. attacked by the teredo.	Percentage attacked.	No. of specimens exposed.	No. attacked by the teredo.	Percentage attacked.	No. of specimens exposed.	No. attacked by the teredo.	Percentage attacked.	No. of specimens exposed.	No. attacked by the teredo.	Percentage attacked.
White oak tie	4	.....	.....	.....	.....	.....	.....	.....	.....	3	1	33
Red oak tie	2	.....	.....	.....	.....	.....	.....	.....	.....	3	1	33
Tamarack tie .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	2	50
White cedar tie	4	.....	.....	.....	.....	.....	.....	.....	.....	4	3	75
Spruce pine tie	4	.....	.....	.....	.....	.....	.....	.....	.....	4	3	75
Yellow pine square timber.	4	.....	.....	.....	.....	.....	.....	.....	.....	4	1	25
Yellow pine pile	3	.....	.....	3	1	33	2	1	50	3	.....	.....
Chestnut tie	4	.....	.....	.....	.....	.....	.....	.....	.....	4	1	25
Cypress tie	3	.....	.....	.....	.....	.....	.....	.....	.....	3	2	66
Spruce pile (without bark)	1	.....	.....	.....	.....	.....	1	1	100	3	1	33
Black oak tie	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Spruce pile (with bark) ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	1	50
Cypress pile .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1	100

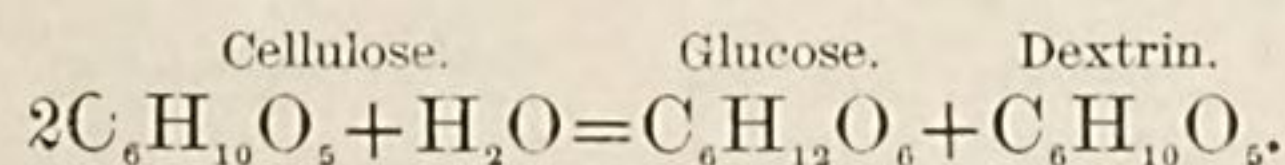
[It is only fair to note in this summary that as the test pieces by the wood creosote and coal oil residuum processes were only three in number in each case, the percentages of failure given should be rated accordingly, as compared with the thirty-one specimens of dead oil of coal-tar treatment.—Editor Engineering News.]

PRESERVATION OF WOOD.

By M. D. SOHON, A. C.

By the term "wood" is meant the portions of the tree included by the trunk, roots, and larger branches. Wood may chemically be divided into three parts, woody fiber, water, and the constituents of the sap. Woody fiber : cellulose, and lignin. Cellulose is the material of which all vegetable tissues are constructed. It presents different appearances, according to the source from which it has been derived, but when separated from extraneous substances it is always the same, no matter whence its origin. Cotton, wool, hemp, and flax consist almost entirely of cellulose. Alone it is not very liable to decomposition, but forming as it does the cellular structure of the plant, it is in contact with the decomposable nitrogenous substances which hasten its decay. Linen, cotton, and paper consist largely of cellulose, and, although they decay, do not decompose so rapidly as wood.

Cellulose is insoluble in all ordinary reagents, dissolves in Schweitzer's reagent (cupro-amm. oxide), and in concentrated sulphuric acid. Boiled with dilute acid it is converted into dextrin and glucose.



Cellulose is not colored by iodine.

Lignin is the other constituent of the woody fiber and cells. Its composition is nearly constant, after the removal of the sap constituents, carbon about 52.47, oxygen 41.9, hydrogen 5.7. It is probably isomeric with cellulose, although the hydrogen seems in excess, and it generally shows traces of nitrogen. It may be prepared from wheat flour by washing out the starch, removing the gluten and fats by alcohol and ether, the lignin remaining as a grayish-white, tough, elastic mass. In the dry state, free from the sap, it suffers no decomposition. It is insoluble in water, alcohol, and ether, dissolves in very dilute hydrochloric acid and dilute alkalies, and is precipitated from the solution by normal salts (NaCl) and by acetic acid ($C_2H_4O_2$). Boiled with sulphuric acid it is converted into leucine, tyrosine, and glutamic acid.

The specific gravity of the fiber is over 1, often approaching 1.5. The specific gravity of the wood varies 0.206 in cortica, the lightest, to 1.426 in iron wood, averaging about 0.6. The hardness depends on the solidity and compactness of the fiber, although generally classed according to their heating power and facility of working: Hard woods, oak, beech, elm, birch, etc.; soft woods, pine, fir, cedar, etc.

The amount of water contained in the wood varies within very wide limits.

	Per cent.		Per cent.
Willow	26.0	Alder	41.6
Sycamore	27.0	Elm	44.5
Mountain ash	28.3	Fir (red)	45.2
Beech.....	30.8	Italian poplar	48.2
Oak	34.7	Poplar (white).....	50.2
Fir (white)	37.1	Poplar (black).....	51.8
Horse chestnut.....	38.7		

By "air drying" the water is not entirely removed, the evaporation continues until an equilibrium is established between the humidity of the air and the hygroscopic power of the wood. Here the variation is only between very narrow limits, and the wood is said to be air dried. By heat, however, 16 to 20 per cent. more can be expelled, but at such temperatures the wood is liable to become brown and decompose. By air drying 20 to 25 per cent. of water can be expelled by from ten to twelve months' exposure.

The sap constitutes 35 to 55 per cent. of the wood; it consists of water holding albuminous matters, sugar, starch, and substances which vary in the species, as tannin in oak, resin in pine, albumen in birch. These organic compounds, especially those of complex structure, are liable to chemical decomposition either by splitting up into less complex substances, or combining with other materials to form more stable compounds. Such changes may be classed in one or both of the following:

The action is oxidation, includes eremacausis or decay; products of decomposition are generally carbon dioxide, ammonia, water, sulphureted hydrogen, sulphides, nitrates, and nitrites. The action is reduction—may be divided; (1) putrefaction, when offensive gases are given off and the products are of no particular value; (2) fermentation, the term applied especially to the conversion of sugar, etc., into alcohol or acetic acid. In both the action is the same. For such action two substances are necessary, a ferment and a fermentable body. A ferment is a substance capable of exciting fermentation, as yeast, gelatinous, and albuminous substances. Any substance that may be brought to a fermenting state is a fermentable substance. Only nitrogenous substances are liable to spontaneous fermentation; albuminous substances, casein, legulin, gluten, gelatine, and tissues decompose in moisture.

Experiments have shown that access of air is necessary to start fermentation, but not to continue it. Fermentation will not take place in air that has passed through a red hot tube, freezing prevents it, boiling prevents and stops it only for a time. The action of ferments seems to be most active between 20° and 40° C. Dryness prevents all fermentation, as do strong mineral acids, except phosphoric, which seems favorable. From this it will be seen that some external agent is necessary to fermentation. Arsenic and corrosive sublimate, poisonous to both animal and vegetable life, prevents it, but nux vomica, morphia, etc., deleterious to animal life only, do not; and experiment has shown this necessary germ to be of vegetable origin, and we are able to promote or stop its progress by providing or withdrawing substances requisite for its support.

Cold and heat prevent action for a time; the latter is generally the more practicable, but some ferments are not destroyed at the temperatures to which we may raise the object to be sterilized; thus yeast germs may exist, especially in alkaline solutions, at temperatures over 100° C., and are therefore not destroyed by boiling.

Antiseptic action may be applied in five ways: (1) Addition of substances to extract water, (2) form compounds less liable to fermentation, (3) destroy the ferment, (4) deprive of air and oxygen, (5) kill the fungi and germs. Each decomposition is brought about by a particular ferment. These are generally cellular microscopic organisms varying in size 0.0001 to 0.001 inch in diameter, multiply by gemmation, and exist in isolated cells or groups. Besides this decomposition or decay, the wood is liable to attacks from worms, insects, and various diseases. Of the boring worms, the two most active are the *Teredo navalis* and the *Limnoria terebrans*. The teredo is most active in salt water, the limnoria also frequents brackish water. Mercuric chloride, copper sulphate, creosote, hydrogen sulphide, and acids are destructive to them, hence woodwork at the

outlets of sewers, etc., is not readily attacked ; resinous woods and woods containing tannin are not so readily attacked as others.

These worms have not been studied to any extent as to their multiplication, etc. The teredo enters the wood by a small hole and rapidly bores upward parallel with the grain, enlarging in diameter to one-fourth or one-half inch, lining the boring with carbonate of lime ; hence it prefers a calcareous seashore. The limnoria, on the other hand, prefers a silicious shore, formed by the decomposition of silicious rocks. Both prefer a warm climate and confine their borings to a space between high and low water marks, showing that they require both air and water.

The diseases of wood generally occur during growth, and can seldom be remedied after felling.

Wet rot is caused by the chemical action in the wood by the decomposition of the sap or of the tissue by the confined moisture, the albuminous substances of the sap beginning to putrefy as soon as the conditions are favorable. Wood felled between April and October is especially liable to wet rot.

Dry rot is the most formidable kind of decay to which timber is subject ; it occurs most frequently in ill-ventilated places, rendering the wood brittle and destroys the cohesion of the fibers, so that after a time it crumbles beneath the touch. The softer and more porous woods are more liable to decay by dry rot. It is caused by a fungus, whose spawn in the sap wood, on the introduction of moisture, causes fermentation, and the decay of the tissues follows. The season of felling influences the resistance to dry rot, that felled in winter being less liable, but the germs of decay may remain inert in the woods for a long time, and finally become evident and active if the conditions be favorable. Once established in the wood it is very difficult to eradicate, the only remedy being to remove all trace of the fungus and disinfect.

Healthy wood is liable to receive germs from the air and water, and these sources are of more danger than the germs contained in the wood itself.

The durability of wood is subject to too great variation to have any limits placed upon it, depending almost entirely upon the exposure to which it is subjected, as to heat and moisture, attacks of insects, etc. Well-seasoned wood in dry situations, or in well-ventilated situations, with uniform state of moisture or desiccation (moisture preferred) should never decay.

The season and manner of felling and working are important in determining the life. Timber felled in winter will outlast that of summer in resisting decay, attacks, dry and wet rot. Hewed wood is also more durable than sawed, from the fact that the pores are closed and the fibers compacted by the blow, while the saw tears the

fiber and opens it. Adzed ties on railroads often outlive similar sawed ties by two years.

Wood has been found in ancient Egyptian temples, known to be 4,000 years old ; here it was protected from moisture and germs, hence was not affected. In 1851, there was on exhibition at the London Exhibition a table made from a piece of timber—probably a door lintel—excavated near Pompeii in 1837 ; when found, the exterior was charred and crumpled but the interior was solid. The piles of London Bridge, built in the eleventh century, were found in good condition when rebuilt in 1829, and the piers of Trajan's Bridge over the Danube are still said to be visible (?) although built 102 A. D. Many other instances of longevity of timber might be cited, also cases in which the life is extremely short, as in stable and brewery floors, etc.

The soil to which the timber is exposed is also a potent factor in the durability. In Maryland and Virginia, railroad ties deteriorate very rapidly ; in Wyoming, on the other hand, there is a stretch of land of about 10 miles on which the ties never decay. Analysis showed the soil to be highly charged with saline compounds, more or less soluble (chlorides of sodium and potassium, carbonates and sulphates of magnesia, lime, etc.), which seemed to mineralize the wood and preserve it.

Alder and beech do not last in dry situations, but do under water, as does oak also.

Insects are often selective in their attacks on wood ; elm, aspen, and resinous woods are not readily attacked. Iron wood is almost invulnerable. In general, woods from colder climates and those grown in dry situations are more durable than those from warm climates and moist places, in that they contain less water and are more compact and less porous.

Regarding the necessity of preserving wood, but little need be said, it depending altogether on local conditions and economy. In situations, as piers or wharves, exposed to such destructive agents as the teredo, some preservative must be used, either coating with metal or tar, or impregnation. In other situations, as bridges, floors, ties, etc., the question to be considered is cost of material and preservative. Where wood is plentiful and cheap it is more economical to use unpreserved timber ; but where good wood is scarce it is often more economical to preserve it, although it necessitates a greater original outlay and time. To counterbalance these we have a greater durability, the lesser cost of repairs and replacing, and perhaps the greater economy, in that a cheaper material, itself valueless, may be preserved to outlive the best unpreserved timber. A comparison and discussion as to the relative values of preserved and unprotected timber will be found in the Transactions of the American Institute of Civil Engineers for the year 1885.

HISTORY OF THE PRESERVATION OF WOOD.

Attempts have been made to preserve wood from the earliest times. In Genesis VI, 14, we read that "Noah was commanded to *pitch* the ark without and within." The Egyptians appear to have used some hydrocarbon preservative, as did also many of the Eastern nations. Charring the ends of posts to harden and protect them is practiced by the least civilized tribes.

Glauber (1548) published two methods for treating wood.

Anderson Emerson (1737) applied to the wood a hot mixture of boiled oil and a poison.

Fagol (1740) impregnated with alum or copperas by immersion in the solution for several days.

John Lewis (1754) received a patent for a preparation from "American pitch pine juice," also for the distillate of "plantation tar" for the preservation of wood.

Haller (1756) recommended the use of vegetable oils.

Jackson (1767) used salt and copperas, epsom salt, alum, lime, and potash.

Humphrey Jackson (1768) patented a method by boiling the timber for several hours in a strong alkaline solution, water, or sulphuric acid.

Pallas (1779) proposed copperas and subsequent treating with lime. Dr. Hales recommended blue vitriol and subsequent coating with coal tar. Dr. Fordyce substituted copperas. This was used with success in the West Indies.

Colonel Colgrove (1784) proposed coating with creosote.

Sir H. Davy (1821) recommended corrosive sublimate. This was patented in 1832 by Kyan.

John Oxford (1822) used "essential oil" of coal tar.

Francis Mott (1836) described creosoting as preservative; this was used by Hall in 1838.

Margary (1837) patented the method of impregnating with copper acetate or sulphate; this has not been successful on a large scale.

Sir William Burnett (1838) patented his zinc chloride process.

Bethel (1842) patented the creosoting process, now in extensive use.

Payne (1840) introduced copperas (FeSO_4), and in 1846 used sodic carbonate. Since then many substances and mixtures have been proposed. The more important American methods are given.

Many of the early processes were tried and failed, perhaps from want of skill in manipulation, and cost.

William Chapman, in a "Treatise on the preservation of timber" (1813), gives results (mostly unfavorable) of experiments with nearly all the preservatives that have since come into use and been patented.

A committee of the Dutch Academy of Sciences, appointed to investigate the teredo, reported no method to be effective, although creosoted timber was unattacked for five years. They did not mention nor do they seem to have tried hydrocarbons or petroleum.

PRESERVATION.

The wood may be preserved or its durability increased by (1) removing water; (2) eliminating or diminishing the sap; (3) by ventilation; (4) by preventing the sap from decomposing by altering the chemical constituents; (5) coating or sheathing; (6) impregnation or mineralization.

The water or sap may be removed in various ways. By seasoning or allowing the wood to become air dried, best in a well ventilated place, under shelter. The wood should be cut in winter, when the sap is least, or in May, before the sap begins to run; vital suction will then draw the sap to the smaller branches. In March and April the average moisture contained is less than 47 per cent., during the next three months 48, and during the winter 51. (Dr. Hartig).

Properly seasoned wood contains about 20 to 25 per cent. water; never less than 10. If the moisture be entirely removed by artificial means, the wood loses its elasticity and flexibility, and becomes brittle. Any artificial seasoning should be carried on very gradually, the initial temperature being low, and the operation should not be carried too far. The seasoning may be hastened by girdling or barking, allowing the tree to stand, the sap being drawn from the wood by vital suction. The drying may be effected in a drying-room by aid of heat; but the action of heat is deleterious to woods.

Timber, after felling, is often immersed in running water to wash out the sap. Theoretically this should be effective, if the water is not contaminated by passing through decaying matter. The water, entering the pores, drives out the sap, or the mineral salts in solution acting on them forms insoluble compounds not liable to decay; but this action, if it does take place, must be incomplete, as the exterior pores would be closed first and prevent the interior from being affected.

Boiling and steaming the wood have also been resorted to. These remove some of the sap, and render other portions insoluble and undecomposable.

Whatever process may be adopted, none is so perfect as to protect against the evils of ill-ventilation, the changes of desiccation to moisture are greater, and the conditions for decay most favorable, and no process has yet been found to prevent decay where it has once obtained a hold on the fiber; for, in preserving, we must protect not only against germs present, but must guard against their future presence.

Preventing the decomposition of the fiber by the chemical alteration of the sap constituents may be effected by various reagents. The albuminoids, the principal factors in the decomposition, are rendered insoluble by mercuric chloride, zinc salts, and mineral acids. The operation by these agents will be considered under impregnation. Beyond these, the only method for its decomposition is by means of heat—direct (charring), vulcanizing, boiling, and steaming.

Boiling and steaming of wood has been tried by various methods. For boiling, the wood is placed in large wooden tanks, covered with water, and kept submerged by stays or weights. The heat is usually supplied by steam, introduced direct or by means of coils. The steaming is effected in closed vessels, generally of iron, with outlets for the condensed vapors, and the steam applied direct or by coils.

Usually the object of this treatment is not so much to increase the durability of the wood as to season it rapidly, and many elaborate apparatus have been made for this purpose. When wood is in direct contact with the steam or water it is softened, and, instead of increasing the durability, decreases it; moreover, wood artificially seasoned by means of heat, or heat and moisture, shrinks greatly in the drying, and often irregularly, unless great care is exercised in the operation. Owing to the expense and uncertainty of this method of treatment its application is not great, and it is chiefly used in the seasoning and softening of woods to be worked or bent, as furniture turnings, and in the preparation of wood for veneers.

Vulcanizing is the process of rendering the sap insoluble and undecomposable within the cells by means of heat. To do this the wood is subjected to such pressure, in a closed vessel, that the sap will not vaporize on the application of heat. Heat is then applied gradually, the pressure being maintained or increased as the temperature rises; about 400° F. is generally sufficient to vulcanize ordinary woods. Such treatment, if complete, should be beneficial to the wood, if the temperature has not been too high, in that the pores are closed by an insoluble substance, which is the object of impregnation.

Charring has been practiced from time immemorial, and with good results. Wood charred on the exterior is found to resist the action of water, decay and the attacks of insects whenever the charring was complete. In charring the preservative reactions are complicated. In the process of charring, the sap from the exterior is partly driven inward and there decomposed in the pores of the wood, vulcanizing it. The charred surface of the wood, consisting of charcoal, is itself undecomposable, resists the attacks of insects, and at the same time acts as a filter, allowing the air and moisture to pass, but retaining the germs of decay.

The temperature employed in charring is an important factor in

the process. Some woods, as pine, cedar, etc., are liable to crack at sudden heating and at high temperature, in the depths of these fissures the charring is necessarily incomplete, and it is through these spots that decomposition sets in, and after it has once obtained a hold on the interior it progresses rapidly, and, although the exterior still appears sound and firm, the interior may be entirely destroyed. The sap deposited in the cells, although not liable to spontaneous decomposition, is still decomposable, especially if the timber be of size that the heat has not penetrated throughout, in which case wet rot is liable to set in, owing to confined moisture, which, having been driven in by the heat, is retained by the stoppage of the pores by the coagulated sap. Charring by sulphuric acid is more complete than by fire, but the objection is its cost; it was mentioned by Glauber (1548).

Carbonized wood is used extensively in the holds of ships, tanks, joists, etc.; in such cases the charring is usually done by a gas or oil flame playing against the surface. In the charring of timber for posts or piles the extremity is placed directly on the fire until charred. Numerous patents have been issued for apparatus to carbonize wood by means of gas, tar, oil, acid, etc.

In some cases, after charring, the timber is dipped in coal tar, which effectually seals it. Posts so treated have been found good after twenty-five years.

Coating, painting, or sheathing wood to preserve it is very ancient, the art of painting having undoubtedly originated in the custom of coating walls to protect them against the weather. The earliest recorded preservative is that Noah coated the ark with pitch, probably the exudation from trees. Glauber (1548) mentions wood tar and recommends its use as a preservative. The preservative action of paints, coatings, sheathings, etc., is merely mechanical, preventing the entrance of water and excluding germs; unless antiseptic it does not prevent the decay of the interior, and such often takes place. Many of the paints, especially mineral, are absorbed to some extent by the wood; here the action is similar to impregnation, but to a less extent. Various methods have been suggested for coating by tars, etc., applying it in a melted state, in solutions, and in combination with other materials. Tallow, resins, and asphaltum have been tried extensively.

Mr. Kretchmar (1889) recommends immersion in copper or zinc salt and coating with alkaline solution of rosin.

Fernoline, a product of the distillation of Georgia pine, is used considerably by the Pennsylvania Railroad Company. It has a specific gravity a little over 1 (1.05), melts about 15° F., burns 220° F., contains 5 per cent. tar, 45 per cent. tar acids, 50 per cent. oils. It has a peculiar penetrating odor, which is a great objection to its use. The large percentage of oils and acids would render it valuable as a pre-

servative and as excluding water. The term "tar acids" here used does not mean, as usually applied, the phenols and creosols (most authorities agreeing that these exist only in small quantities in wood distillate—which is discussed in connection with creosoting), but that portion soluble in caustic alkali. The tar is that portion insoluble in 88° gasoline, and the oils are found by difference. As used by the Pennsylvania Railroad Company, fernoline is applied, by the brush only, to all joints, mortises, and spots where decay is liable to set in. Its use is of too recent date to allow of judging its value, and although four or five years in use it is said to yield good results in protecting against the teredo in ferryboat and stable floors, where the action of the urine of horses is very strong, and for the bottoms of cars carrying wet lading. Fernoline has also been successfully used on docks, etc., in New York City.

Dead oil of coal tar, asphaltum, petroleum residues, and sludge acid tars have also been used with more or less success as coatings.

IMPREGNATION.

Impregnating methods may be classed (1) by solution of salts, simple; (2) successive steepings or impregnations; (3) by oils, tars, etc.

Salts of almost all the metals have been used in the preservation of wood. They are applied in two ways (1) by steeping the timber in the solution of the salt until saturated or until it has absorbed a sufficient amount, either at normal temperature or artificially heated; (2) by pressure; the timber is placed in a closed vessel and heated by steam, and vacuum applied to exhaust the sap; a large amount of sap may be removed by heat or vacuum alone, but they are not sufficient to extract all. After the removal of the sap the solution to be injected is forced in until sufficiently saturated. Boucherie utilized the vital suction to inject the solution, also hydrostatic pressure.

Common salt was undoubtedly the first mineral preservative used, and has been used in ships from the earliest times, as also in the preservation of flesh and vegetable matters from decay. Injected into the wood it renders it very flexible, and to some extent incombustible. But it is not retained in the pores, and is easily washed out, and on drying, by its crystallization within the cells, greatly impairs the strength. Glauber recommends steeping in sodic sulphate (Glauber's salt), drying and resteeeping several times, and finally charring with sulphuric acid. Potassium salts act similarly to sodium salts.

Dr. Reinsch (1870) recommended treating with a solution of one part water glass and three parts water for twenty-four hours, dry for several days and repeat, and finally coating with cement.

Ammonium salts tend to render the wood incombustible, espe-

cially the sulphate. Tungstate of soda also renders it incombustible.

P. Folacci's (1875) solution for rendering wood incombustible; zinc sulphate 25 parts, "American potash" 10, ammonium alum 20, manganese dioxide 10, sulphuric acid (66°) 10, water 25. The salts are mixed in an iron tank with water at 45° C., and the acid slowly added. The wood is placed in suitable tanks and boiled 3 hours with the solution.

M. Martin's solution for fireproofing light tissues, etc., indorsed by the French Society for the Encouragement of Natural Industry (1880), consisted of ammonium sulphate 8 kilogrammes, carbonate 2.5 kilogrammes, boric acid 3 kilogrammes, borax 2 kilogrammes, starch 2 kilogrammes, water 100 kilogrammes. For painted decorations ammonic chloride is added.

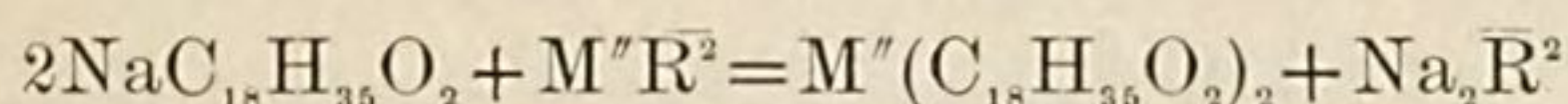
Earthy chlorides, as barium and calcium chlorides, render the wood incombustible, and are not so readily washed out as salt, and, owing to their greater affinity for water, extract it from the wood on being seasoned, hence preserves it. Their action, however, is not permanent. According to Boucherie a quantity of acetate of iron must be added to secure good results.

Lime exercises a preservative influence on wood; lime boxes seldom decay. Mr. Lostel (1878) buried the timber in the ground and covered it with calcined lime, which was gradually slaked by water. In eight days the operation was complete.

Milk of lime has also been used; lime however, renders the wood brittle. In whitewashing it acts as a disinfectant, and is probably absorbed somewhat. In a pine board fence, which had formerly been kept whitewashed, lime was found three-eighths of an inch from the surface, although the fence had not been coated for over three years; adjacent unwhitewashed timber had long since decayed. The action of lime probably decreases after it has been converted into the carbonate, but it is still effective.

Szerelemey's method consisted of two operations, (1) immersion in boiling solution of potash and lime, then treat with cold dilute sulphuric acid, sulphates of lime and potash being formed; and (2) coating with compound of petroleum, asphalt, lime, and sulphuric acid.

Insoluble metallic soaps formed within the wood by the reaction



have been often suggested and tried with little or no success.

Aluminium is less efficient in preventing putrefaction than the heavier metals. Iron salts protect from dry rot, but are not very effective against putrefaction. The facility with which iron receives and imparts oxygen renders its advantageous use questionable; piles studded with iron nails were not attacked by insects or worms, probably on account of the iron absorbed in the fiber after oxida-

tion, but the burning of fiber about the nail was considerable, so that in some cases the nails fell out. This oxidation, together with the shrinkage of the wood, is apparent in railroad ties which, after a time, are unable to hold the spikes, or in any position where wood is in contact with iron exposed to the weather. Copperas (FeSO_4) is a good antiseptic, but only on account of its oxidizability; when oxidized it no longer acts; the ferric salts formed are largely basic and insoluble, and these deposited in the pores of the wood, if inert, would act as any other substance to preserve it, but itself destroys the wood by oxidizing it. Moreover, the salts so deposited are not, necessarily, poisonous, being insoluble, and although the timber so impregnated is not rapidly attacked, it is not free from decay or insect attack. The chief objection which has been raised against it is, that it renders the wood brittle and weak, probably due to the cause given—oxidation.

Crude acetate of iron, made by dissolving iron scrap and scale in pyroligneous acid, is greatly superior to the pure salt—it prevents putrefaction and dry rot. Its antiseptic power is due in a great measure to the tar present, pyrolignite of iron dissolving more tarry matter than any other aqueous solution.

Payne (1842) invented his iron process; at first iron was used alone, then a double process was adopted. The wood is introduced into a cylinder and steam admitted to expel the air and sap, some cold copperas solution is then run in; this, condensing the steam, formed a vacuum, drawing out more sap—this was completed by the pump. Ferrous sulphate solution was then run in and forced into the wood; in a few minutes the solution was drawn, the wood again steamed, and a solution of barium chloride forced in, whereby ferrous chloride and barium sulphate are deposited in the wood.

Buchner and Von Eichthal used ferrous sulphate and then impregnated with soluble glass.

Copper salts have had various successes and failures. The cuprous salts are undoubtedly the better theoretically, but the cost places them out of the question for extensive working. Copper checks and prevents dry rot and putrefaction more effectually than iron; it is highly poisonous, renders the wood very hard and somewhat brittle, but does not destroy it as iron does, but is injurious to tools in working, and is still removed by washing.

Boucherie's process, introduced in 1840, was and still is used extensively in France with success. His first method was to utilize the vital suction of the tree. A tree was stripped of its branches, leaving only the topmost boughs, a hole was bored longitudinally through the trunk near the ground and the trunk sawed through to about 1 inch. The cut was then covered with tarred cloth and the hole connected with a vessel containing 1 per cent. solution of blue vitriol. Rapid absorption takes place, large trees may absorb 200 to 300

litres; the liquid rises in the stem, driving the sap before it into the extremities. In poplar it rose 30 metres in seven days. In ten days the impregnation is complete except in the innermost parts.

Boucherie first used acetate of iron (1 to 50 of water), then cuprous chloride; as the iron made the wood hard and difficult to work. Coloring matters were also introduced; mineral pigments worked successfully, vegetable colors, however, were found not to be rapidly or readily absorbed.

In his second method Boucherie used hydrostatic pressure; the timber was stood on end, an airtight cap fitted on and connected with a reservoir at an elevation of 80 to 100 feet, and the sap forced out. By this means the sap was forced 10 feet in eight hours.

	Pounds.
Oak absorbed .....per cubic yard..	10-20
Deal absorbed .....do.....	15½
Beech absorbed.....do.....	20½
Poplar absorbed.....do.....	20¾

H. Flad, of St. Louis (1882), patented a method to charge by sucking the solution through. It is said to have been successful.

Saturating by immersion is objectionable on account of the length of time required for complete saturation. Injection by pressure did not yield good results; moreover, the use of copper salt necessitates the use of copper tanks and vessels, iron being attacked, thus greatly increasing the cost of the operation.

Copper salts have been used by the Thilmany process (described under zinc impregnation).

Zinc chloride and sulphate have been the bases of many processes and the subject of much controversy; while it is universally agreed that zinc should and will preserve the fiber, its permanency is a matter of dispute. Theoretically the zinc would combine with the wood and be retained; in many cases, however, the zinc has been found to have totally disappeared in a short time.

Considering the failures and questionable results, it is noticeable that in all these cases the timber was in exposed situations, where the zinc is liable to be washed out by the rain. A noted case of this kind was in New York City; a wood pavement was impregnated with zinc chloride; in one year no trace of zinc was found, although it was proven to have been thoroughly impregnated. In those cases of favorable use the materials seem not to have been exposed to the direct action of the weather, as in ties, stringers, etc., which are more or less buried and covered by ballast. The Wellshouse process, treatment with glue, prevents the washing out, hence results in exposed places are better than where the simple salt is used.

Burnett, in 1831, discovered the preservative action of zinc salt, and patented his method in 1838. The original method was steeping the timber in a solution of the chloride (1 pound to 4 gallons of

water); this was tedious and ineffective, and it was not until Bethel introduced the injection process and it was adapted to Burnettizing that the latter became a success.

The timber is loaded on trucks and run into an iron cylinder, which can be closed. A vacuum of 20 inches is applied, together with heat, for about two hours, a dilute solution of zinc chloride is then carefully run in during fifteen minutes; a pressure of 100 to 150 pounds per square inch is then applied for one to four hours, according to the size of the wood. The operation requires great care and attention to secure good results.

Wellshouse process (St. Louis Wood Preserving Company), patented 1879, is a modification of Burnett's, by which the washing out of the zinc is prevented. The timber is steamed in a cylinder one to three hours (according to size), zinc chloride and glue solution is then forced in, after which tannin is injected; the purpose of the glue being to combine with the tannic acid in the wood, precipitating the glue as an insoluble compound, and retaining the zinc. The tannic acid is added to precipitate the excess of glue.

Zinc gypsum process, patented by H. Hagen (1883); zinc chloride and gypsum ($\text{CaSO}_4 + \text{Aq.}$) are injected in one solution, it being claimed that the crystals of gypsum formed cover the fiber and retain the zinc.

Thilmany process (American Wood Preserving Company, Defiance, Ohio); for this process green wood is preferred, the dry requiring to be longer steamed. The timber is run on flat cars into a cylinder 80 feet long, 6 feet in diameter; steam is applied to drive out the sap, and an air-pump connected to draw air and condensed moisture and form a vacuum. The cylinder is then filled with a $1\frac{1}{2}$ per cent. solution of zinc (or copper) sulphate and a pressure of 80 to 100 pounds applied until charged. The sulphate solution is then drawn and a 1 per cent. solution of barium chloride similarly charged. The reaction $\text{BaCl}_2 + \text{ZnSO}_4 = \text{ZnCl}_2 + \text{BaSO}_4$ takes place, the precipitated sulphate retaining the chloride. This process worked well on pine and white oak, soft timber being hardened, but did not succeed on the swamp woods near Defiance. For these stronger solutions were necessary (3 per cent. zinc sulphate, $3\frac{1}{2}$ per cent. barium chloride). It has been successfully applied to paving blocks in Detroit and brewery floors, at a cost of about 10 cents per cubic foot.

Cost of Burnettizing is about \$5 per 1,000 feet, B. M., or 20 to 25 cents per tie. In Germany it has been done for 5.8 to 19.2 cents, and in the United States as low as 15 cents per tie. The Philadelphia, Wilmington and Baltimore Railroad Company paid 25 cents per tie, and the Philadelphia and Reading Railroad Company 35 cents.

Burnettizing has not been so successful in the United States as in Europe. This may be traced to several causes: Imperfections of the Bethel method, the vacuum being insufficient to free from sap;

this was improved by the introduction of steam. In the United States the pickled timber has been used generally in bridge construction and failed; in Europe it was used in protected situations and was successful. Insufficient pressure applied; haste of operation; eight hours at least are necessary for complete impregnation.

If the solution be too strong the wood becomes brittle, perhaps from the formation of crystals. Decay sets in from the outside, following the removal of the zinc.

Mercuric chloride, corrosive sublimate, was suggested by Davy and Knowles in 1821, but was first used by Kyan in 1832 (patent in United States 1838).

The Lowell Canal Company began its use in 1848 for bridges, etc., with successful results. They used two pits of masonry, each 49 feet long, 7 feet 4 inches broad, and 4 feet deep, capable of holding 10,000 feet, B. M. The material is handled by cranes and kept submerged by stones. The solution used is 1 per cent., by weight, chloride, and 4 to 5 pounds are injected per 1,000 feet, B. M. The timber is allowed to soak one day for each inch of least diameter, and two additional days, and then dried.

The Eastern Railroad Company use four tanks, 60 feet by 9 feet 6 inches by 6 feet of granite, laid in cement, the interior coated with coal tar. The liquor is stored in an iron tank, coated with tar, and all pipes, etc., are of rubber or wood; about 2.6 pounds are injected per 100 cubic feet, wood of rapid growth absorbing more than slow growing and seasoned than unseasoned; it also bears the solution weaker. The timber is soaked one day per inch with two extra days; cost is about \$3 per 100 cubic feet (\$2.50 per 1,000 feet, B. M.).

The timber is piled in the tanks and old liquor run in from another tank until the wood is covered; the solution is then heated by steam and chloride added until the hydrometer shows the proper gravity. When sufficiently charged the liquor is drawn and the wood allowed to drain before withdrawing from the tanks.

Attempts have been made to adapt Bethel's method to Kyanizing, to hasten the operation, but by this means the amount absorbed was too great; more dilute solution was then substituted, with the natural result of poorly impregnated timber, which passed for good, and the process received a bad name, from which it has never recovered. The original cost of Kyanizing was \$12 to \$14 per 1,000 feet, B. M.; now it can be done for \$3 to \$5.

The first American experiment in Kyanizing was of chestnut ties on the Baltimore and Ohio Railroad, near Baltimore, in 1838; these, on a lime soil, were found good after eleven years (1849), while similar untreated wood lasted only seven years. The cost was about 12½ cents per cubic foot, and the cost of the untreated tie 12 to 16 cents; it was not regarded healthful, salivating all the men, and was discontinued.

The action of mercuric chloride injected into the wood is complicated ; it is itself highly poisonous ; a good antiseptic and disinfectant, it combines with the albuminoids, forming insoluble compounds, and with the lignin and cellulose, and is retained in the wood. Cellulose dipped into the solution gave no mercury to water after washing, although it yielded it to nitric acid. But it is to be questioned as to whether, in this combined state, it still retains its antiseptic powers, and whether its action is not rather as a filler than preservative proper ; it is known that although theoretically combined in insoluble compounds, is is, practically, washed out, especially in salt and acid waters.

Admitting that it is a successful preservative, there still remain several objections : (1) Hygienic ; the effect of mercury on the system varies with the individual. In the use of mercurial preserved wood no cases of poisoning are recorded except at the works, where salivation was complained of. Doubtless there were other cases which were attributed to other causes. By conducting the process by machinery and by persons not susceptible to its influence the danger at the works was reduced to a minimum. (2) The presence of mercury in lumber renders it hard and difficult to work, and injurious to the tools and workmen. (3) The cost ; the value of the machinery, sublimate, and cost of repairs prevent its use except in special cases when wood is scarce or particularly liable to decay and no cheaper method can be used.

The foregoing are the more important substances used which exercise any chemical action on the fiber. Many other metallic preservatives have been proposed and tried. Some of these will be found in the list of American patents.

W. R. Huffnagle, for the Philadelphia and Columbia Railroad Company (1840), soaked ties in concentrated urine three months. In 1850, on the Belvedere Railroad (A. Welch), auger holes were filled with salt and plugged.

S. W. Moore (1873) impregnated with lime under pressure, then with sulphurous acid. This was said to render the specific gravity lighter, but its value is doubtful.

William Youngblood (1889). The dried wood is saturated with nitre and red sanders in water and then with paraffine. The paraffine alone would fill the pores and act as preservative.

IMPREGNATION BY TARs, OILS, ETC.

Coal and wood tars and dead (creosote) oil are the only ones used to any extent, although many resinous and tarry substances have been proposed.

Tars are oily bodies of varying specific gravity derived from the dry distillation of organic materials, and differ greatly in composition according to the materials employed and manner of conducting

the operation. They are, natural, as asphaltum or petroleum ; artificial, wood, peat, lignite, or coal tar. Wood and coal tars are very similar, but in the latter phenol and cresol predominate, and in the former guaiacol, creosol, and monomethylic ethers of pyrocatechin and homopyrocatechin. In wood distillate (peat and lignite tars rank between wood and coal tars in composition) solar oil and hydrocarbons of the fatty series (C_nH_{2n+2}) are found, while in the coal tar the hydrocarbons are of the aromatic series (C_nH_{2n-6}).

Coal tar was not commercially distilled until 1846. The process is varied in different localities. The separation of the distillates is either according to specific gravity or temperature.

	Distillates.		Average.
	American.	German.	
	° C.	° C.	Per cent.
Ammoniacal liquors	105	.....	.....
First runnings.....	110	.....	2.5
Light oil.....	210	170	5.0
Carbolic acid.....	240	236	} 27.5
Creosote (dead) oil.....	270	270	
Anthracine.....	To end.....	End.....	10.0
Pitch and residue .....	.....	.....	55.0

Creosote oil contains naphthalene, methyl naphthalene, anthracene, and phenanthracene, and alcohols of the aromatic series (phenols), small quantities of aniline and several indifferent oils not completely isolated.

Specifications for creosote oil.

	Great Western Railroad (England).	French railways.
Specific gravity ...	1.045 to 1.055, at 60° F.....	1.030 at 35° C.
Naphthalene.....	Less than 30 per cent., separate, at 40° F ...	Less than 30 per cent.
Acids	10 per cent. (5 per cent. carbolic).....	8 per cent. phenol.
Heat.....	90 per cent. distillate, at 600° F... ..	One-third distillate between 200° and 250°.
		Two-third distillate above 250°.
Cold .....	.....	Liquid at 35° C.

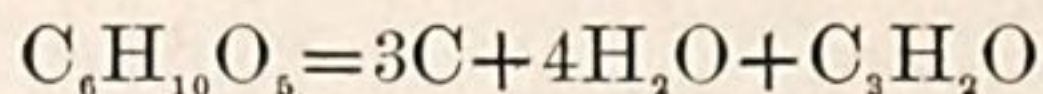
The presence of naphthalene is not desired in large quantities, although it is itself a preservative; the only apparent objection is that it lessens the percentage of acids by dilution, and may increase the difficulty of injection. It has been used as a preservative, but is said to vaporize, leaving the wood unprotected, but this evaporation must be slow, and the greater portion of that leaving the wood does so immediately after the removal of the pressure. The

phenols or acids are constituents mostly desired, and are estimated by Tidy's or Abel's methods.

Tidy's method.—Distill 100 cubic centimetres until no more passes out at 315° C. The distillate is shaken with 30 cubic centimetres caustic soda (specific gravity 1.20) boiled and cooled and agitated. Pour into a separatory funnel and separate soda solution, treat residue twice with 20 cubic centimetres soda. Mix the three liquids, cool, and separate any oil by means of funnel, boil to remove traces of oil. Cool and mix with 35 cubic centimetres sulphuric acid (sp. gr. 1.3) until acid. Pour into separating funnel and let stand two hours, until the acids separate. Dissolve the acids in 20 cubic centimetres caustic soda solution and 10 cubic centimetres water, boil, filter through asbestos (wash with as little water as possible). Cool completely in a graduated (100 cubic centimetres) cylinder, and acidify with sulphuric acid, let stand, cold, two hours, read percentage (cubic centimetres) of carbolic acid.

Abel's method.—Distill 100 cubic centimetres to 300° C., mix with 20 cubic centimetres sodic hydrate (sp. gr. 1.21); shake occasionally for three hours. Pour into a burette, with some soda solution in the bottom, let stand twelve hours. Separate the alkaline liquid into a flask with graduated neck. Agitate residual oil with 10 cubic centimetres soda and add to first solution. Mix with sulphuric acid till faintly acid, and cool, add mercury to drive the acids into the neck and read percentage (cubic centimetres).

Wood distills very nearly in the proportions indicated by the equation :



Products are, carbon, 20 to 30 per cent. ; acid water, 28 to 50 per cent. ; oily tar (light and heavy), 7 to 10 per cent. ; gas and loss, 28 to 37 per cent.

Wood creosote oil, distilled between 180° and 300°, contains phenol (?), paracresol, alpha metazylenol, guiacol, creosol, cærulignol, dimethylic ethers of pyrogalllic acid, etc., and other bases peculiar to the wood.

Wood creosote is a powerful antiseptic, it is rather more miscible with water than dead oil, which it resembles somewhat. It has a strong pungent odor.

Experiments tried in New York (department of docks) in 1885, on the absorption of wood creosote, by immersion of different woods, resulted as follows :

Yellow pine plank, 4 inches thick, immersed in fernaline oil (wood creosote) twenty-four hours absorbed 2.94 pounds per superficial foot. The same immersed forty-eight hours, 3.21 pounds per foot. White pine immersed six hours, 1.125 pounds per foot ; twenty-four hours, 1.425 pounds. Spruce immersed six hours, 1.5 pounds per foot ; twenty-four hours, 6 pounds.

Owing to the length of time required, and the uncertainty of the operation, saturation by tar oils by immersion is not practiced to any extent.

Bethel, in 1838, proposed the impregnation by creosote oil and pyrolignite of iron. The timber was placed in iron tanks filled with oil, pyrolignite was then forced in at a pressure of 125 to 150 pounds for six or seven hours, the wood absorbing 6 to 8 pounds per cubic foot. This method was not found to succeed until Breant, in 1841, proposed heat and vacuum to aid in the removal of the sap. With this modification the creosoting process is used extensively in Europe and America.

The Houston and Texas Central Railroad Works employ Texas pine, a very porous and perishable material, which, unprotected, is destroyed in two years. The timber is placed in a cylinder 100 feet long, and steamed; the steam and sap are then withdrawn by pump and the oil introduced at a temperature of 160°, and a pressure of 20 pounds applied for about thirty minutes, and then increased to 100 pounds. The time varies with the wood. Seasoned timber is preferred; green often requiring four hours' steaming. Steaming thirty minutes and four hours at 100 pounds pressure are the usual limits.

The New Orleans and Mobile Railroad have an extensive plant at West Pascagoula, Mississippi. The works contain two reservoir tanks for storing oil, two heating tanks, 6 by 100 feet, condensers, pumps, superheaters, etc. Each heating tank contains 5,000 feet of 1-inch pipe in coil, through which superheated steam may be passed to season the timber; and rails on which cars are run. Both heads of the cylinder are movable. The piles are cleaned of dirt and bark, batted and shaped, loaded on iron cars, and drawn into the tank. Steam is then turned on through a perforated pipe in the bottom and continued until the mass is heated throughout. Superheated steam is then passed through the coil to vaporize the sap, which is drawn by a vacuum pump, a partial vacuum being maintained; the sap vaporizes rapidly at a low temperature. When the seasoning is complete the tank is filled with oil and 150 to 200 pounds pressure applied and continued until the gauge is constant, showing that no more is absorbed. The oil is then drawn, the charge removed, and the tank filled for the next charge. By this means 12 to 18 pounds (1.25 to 2 gallons) can be injected per cubic foot.

The Creosote, Lumber and Construction Company, at Fernandina, Florida, on the Amelia River, have works which consist of retorts and a general building for the treatment of timber. The oil is obtained from distillation of pine and is made by the company at its works. The timber from which the oil is made is obtained from the surrounding woods. The acid is separated from the oil and

allowed to run off as waste into the river. The wood, after the oil is distilled from it, furnishes charcoal for heating purposes.

The building for treatment of timber contains a general furnace and boiler for running machinery, derrick, force and vacuum pumps, superheaters, etc. There are two treating cylinders, one 80 feet long, the other 100 feet, and about 6 feet in diameter. These contain each about 5,000 feet of pipe connected with the superheater, and rails for the carriages. The cylinders are connected so that they may be used together or separately. At the ends of the cylinders are movable doors fitted with rubber and fastened by bolts. A large tank, 24 by 60 feet, is under the floor, which contains the oil for treatment, and is connected indirectly with the retorts. When timber is under treatment, heat is first applied, gradually increasing until the superheater is used with a temperature of 500° F. The vacuum pump is then put in operation. Both of these prepare the timber for the oil, and much depends on their proper manipulation.

The oil is then run into the cylinder and forced in with a force pump of 150 to 200 pounds, until the gauge shows that the required amount of oil, which the specifications demand, has been absorbed.

The treatment of a charge requires on an average twenty-four hours.

Creosoting is by far the best method of preserving wood yet in use, both as to economy and endurance. Its success is scarcely questioned in Great Britain and America. In Germany and France it is used extensively and successfully and is replacing other methods. The details of working and amount impregnated vary in different countries, according to the exposure to which it is subjected. In England seasoned wood is used, requiring little or no steaming; by German methods seasoned wood is sometimes steamed, in the United States freshly cut wood is generally used, requiring to be steamed, which, with the longer time and labor necessary, increase the cost sometimes so as to almost prohibit its use.

English works impregnate 10 to 12 pounds; in France, to protect against teredo, 19 pounds are used; in America, along Nova Scotia, where lymnoria is abundant, 15 pounds are used; along New England and the Middle States 12 pounds are sufficient; but in the Southern States, and along the Gulf of Mexico, 16 to 20 pounds are necessary. The cost in the United States is considerably higher, owing to labor, which is therefore reduced as low as possible; and of material, which, especially since the introduction of water gas and electric lighting, is not equal to the demand.

The cost of creosoting is from 14 to 20 cents per cubic foot (\$12 to \$20 per 1,000 feet, B. M.) for marine use, or 12 to 16 cents per cubic foot (\$10 to \$14 per 1,000 feet, B. M.) for protection against decay only.

The life of the timber is in many cases doubled. The timber should

be trimmed before, and not after, impregnation, as the heart being denser is not always (in fact, seldom is) impregnated, and by cutting would be exposed and unprotected, although the wood is not hardened to prevent cutting, if necessary. The best woods for creosoting are those most perishable without it, as they are generally more porous and absorb a greater quantity. Thus Virginia and North Carolina pine are better than Georgia pine, and black oak than white. The wood should contain as much sap wood as possible, as this is always saturated.

The action of creosote is both mechanical and chemical; besides the "acids," it contains other antiseptics, but the preservative action is probably due more to the pores being filled with gums and insoluble oils, etc., keeping out the moisture. Pure carbolic acid has been tried and does not preserve the fiber, while the distillates of coal tar at the highest temperatures, containing no phenol, does. Moreover, wood creosote, which has proven a most successful preservative, contains no carbolic acid (or very little), although it has other antiseptics equally as efficacious.

As a preservative, creosoting holds its place alone; it is the only security against sea worms (teredo, etc.); it prevents putrefaction and decay, and it not removed by water. Objections have been made against it on the ground of injury to the waters, killing of fish, liability to fire, etc., but as yet they seem to be without foundation.

The use of crude petroleum as a substitute for dead oil can scarcely be said to have been successful; the volatile, inflammable constituents would tend to make it a doubtful preservative. The higher distillates of petroleum, paraffine oil, etc., have been used more successfully, except that they are more valuable for other purposes. Petroleum residues are used for dipping, etc. Rosin solutions, linseed oil, and many other organic substances have been proposed, regardless of cost, and, seemingly, of all the laws of nature. Some of these are given below.

The cost of the creosoting process and the quantities of material required led to attempts to impregnate by vapors of the hydrocarbons. This was generally done by generating the vapors in a retort and conducting them into the treating tank, where they were to be absorbed by the timber. Most of these proved unsuccessful; in many cases no hydrocarbons were to be found in the wood. Some of these are mentioned below.

The pressure of the atmosphere to force in the preservative has been suggested. Baron Champy recommended dipping the green wood into melted tallow at 200° F. The water and gases are expelled by the heat, and on cooling the tallow is forced in by atmospheric pressure. It is to be questioned as to whether the tallow would not

solidify before the interior is sufficiently cool to allow of a vacuum being formed. Payne substituted resin.

Hatzfeld (1879) recommended the use of tannin and pyroacetate of iron. This was used in railroad timber and telegraph poles in France. The wood was treated in a closed vessel at high pressure, with tannin decoction (chestnut or oak bark), and afterward with a solution of pyroacetate of iron. Iron tannate is formed in the wood and is easily oxidized and retained in the cells.

AMERICAN PATENTS FOR PRESERVING WOOD.

Year.	Patent No.	Remarks.
1837	232	A. Gotthieff. Saturation of wood by tar or pitch, with or without use of salt, diluted with turpentine or benzine, if necessary. By heating 1 to 12 hours at a temperature of 300° to 400° F.
1837	391	R. Bill. Covering wood in a tank by coal tar and heating to 350° F. for about 6 hours.
1837	449	L. Paimboruf. A fire-proof paint. Slaked lime mixed with water or skim milk or rice paste to the consistency of cream. To 100 gallons of above add 20 pounds alum, 15 potash, 1 bushel salt; if <i>white</i> , add 6 pounds CaSO ₄ and clay.
1838	800	J. H. Kyan. Process of Kyanizing. Specifications call for 1 pound zinc chloride per 5 gallons water.
1838	877	Ringgold and Earle. Timber is boiled in strong lime water. Holes are bored in the timber, filled with lime and petroleum or tar, and plugged.
1838	934	E. Earle. Timber is boiled 5 or 6 hours in solution of sulphates of iron and copper.
1844	3635	C. F. Spicker. Method to preserve and color wood. Soak in solution of 6 pounds oak bark, 5 pounds potash, 10 gallons water (+ color) 2 to 4 weeks. Dry 1 week, soak in clear water 1 week to extract potash. Or color by copperas.
1846	4560	P. Von Schmitt. A creosoting apparatus.
1850	7399	Charles Payne. The sap is exhausted, and a <i>sulphur compound</i> , as BaS, FeSO ₄ , etc., with or without salt, forced in at pressure 110 to 150 pounds.
1862	35811	H. de Lapparent. Process of carbonizing by gas flame after the parts have been put together.
1864	43191	B. S. Forman. A composition of salt, arsenic, and corrosive sublimate. Two-inch holes were bored three-fourths way through the planks, filled with the powder, and plugged. Or the fresh cut timber was piled and the layers sprinkled with the powder (20 pounds per 1,000 feet) and heated until fermentation began, when the salts deliquesce and are drawn by capillary attraction into the wood.
1864	{ 45537 } { 45538 }	H. Thayer. Treatment of wood for box covers. The wood is steamed some hours until soft, then cut to one-sixteenth inch diameter, dried for 4 days, smoothed, and varnished with shellac.
1865	47132	L. S. Robbins. The surface moisture is driven out by heat, and the wood saturated by coal tar or resinous vapors. A retort for generating the vapors and a treating tank are used. The timber is heated to 212° to 250° to remove water, which is condensed and runs out. The heat on the retort is then raised until the vapors pass over, and continued until done.
1865	46873	C. Brandenburg. No. 1. A composition to preserve wood and coat barrels. Linseed oil, 1 gallon, boil; add manganese dioxide, one-half pound; heat to 450° F. 8 or 9 hours; cool, add 2½ pints benzine; this is oil of manganese. No. 2. Plumbago, 1 part; hydraulic cement and gypsum 6 parts. No. 3. Caoutchouc, 1 ounce, in methyl alcohol; evaporate alcohol and add benzine. For use mix seven-eighths pint No. 1, two-thirds No. 2, liquefy with No. 3.
1865	48636	A. Hamar. Forcing a 1 per cent solution of copperas through the wood until it emerges at the other end of the same strength.
1865	48882	P. Hugon. Method of carbonizing wood by gas jet, etc.

American patents for preserving wood—Continued.

Year.	Patent No.	Remarks.
1865	49146	G. Palmer (reissued 1872). No. 5040. A method of applying heat to open the pores of the wood and impregnate with oils, etc.
1865	49382	Cooley, Smith, and Bradley. A "filler" consisting of turpentine or benzol, 2 gallons; boiled linseed oil, 1 gallon; calcined magnesia, one-half pound; japan, 2 gallons; starch, 20 pounds.
1865	50384	E. S. Pixley. A filler of glue, 1½ pounds; acetic acid, one-half pound; vinegar, 1 gill; boiled oil, one half pint; alcohol one-half pint.
1865	51528	A. Hamar. Impregnating with concentrated salt and calcic chloride by a process similar to Boucherie's.
1866	52046	N. R. Holmquist. A filler for cavities, cracks, etc., of timber. Linseed oil, one-half pint; flour (paste), 1 gill; zinc sulphate, 2 ounces; litharge, 2 ounces; chalk, 1 pound.
1866	53217	H. L. Eddy. Preserving by immersion in petroleum until saturated.
1866	53267	F. M. Buell. Method consisted in coating with a paste and coal or gas tar.
1866	54194	H. S. Meyers. A preserving composition of chalk, white lead, Spanish white, plaster Paris, glue, and water.
1866	55216	F. Ransome. Treatment with soluble glass, and subsequently decomposing it in the pores by means of an acid.
1866	57545	W. K. Miller. Method of carbonizing burial cases.
1866	57960	J. Perry. A filler to be rubbed into the wood of siliceous marl with (any or all), sulphate of zinc, sal ammoniac, gum arabic, gum tragacanth, and oil.
1866	58036	Sabathe and Jordan. Impregnation by metallic soap, deposited from hot solution.
1866	58203	C. S. Benjamin. A filler of gum copal, 1 pound; turpentine, 1 quart; alcohol, 1 gallon; shellac, 2 pounds; beeswax, 4 ounces; Japan drier, 1 gill; thickened with starch.
1866	58426	B. H. Jenks. A process of seasoning woods.
1867	60794	J. L. Samuels (reissued 1872). A composition to prepare, harden, and preserve wood. To be injected or saturated by soaking. Solution: Fe So ₄ , 1 pound; lime, three-fourths pound; water, 1 gallon.
1867	62295	W. H. Smith. Incasing the timber in earthen pipes; fill with hydraulic cement.
1867	62334	A. Holmes. Preserving by applying a composition which fills the pores and hardens on the surface, excluding air and moisture, or the wood may be previously boiled in sulphate of iron. Composition consists of coal tar, slacked lime, water lime, mineral paint, each one part; ground stone or sand, 10 parts.
1867	62956	T. Hanvey. The wood is boiled with a solution of salt, saltpeter, or sulphate of copper; gas tar, petroleum, or other antiseptic substance is added and the boiling continued until the wood is saturated.
1867	63300	D. R. Prindle. The timber is soaked in hot coal tar, afterward coated with tar residue and finally dusted with sand.
1867	64703	George Pustkutch. The timber to be treated is placed in a chamber surrounded by a boiler, in which the steam from the pumps is generated and at the same time heats the timber; the cylinder is filled with steam, the sap exhausted, etc., the vacuum drawing the oil into the cylinder, where it is forced into the wood.
1867	65545	Constant and Smith. An apparatus for impregnating with tar vapors, generated in a retort and conducted into the heating chamber.
1867	67104	Clarke, <i>et al.</i> The timber in a closed chamber is charged with superheated vapors, which are subsequently condensed in the pores, filling the wood with an oleaginous preservative. The process to be also applied for coloring.
1867	68069	S. T. Harding. Composition for preserving: Lime, 12 pounds; arsenic, 4 pounds; salt 6 pounds; plaster Paris, 12 pounds. To 1 pound mixture add 8 gallons water. Soak 10 days.
1867	68089	P. Koch. A method of cutting paving blocks to increase durability by supplying drainage channels and protecting.
1867	69165	J. F. Bernard. A filler: Asphaltum-varnish, 1 pint; linseed oil, 1 quart; turpentine, 1 quart; French yellow, 1 pound; whiting, 2 pounds; plaster of Paris, 2 pounds; Vandyke brown, ½ pound; pumice stone, 1½ pounds.

American patents for preserving wood—Continued.

Year.	Patent No.	Remarks.
1867	69260	C. A. Seely. Method of impregnating. The timber is immersed in an iron tank of oil; heat to 212° to 300° F. to drive out moisture; replace the hot oil suddenly by cold oil, whereby it is forced into the wood by condensation. Four pounds per cubic foot may be so injected.
1867	70761	T. H. Taylor. In a retort (No. 1) are placed creosote, 5 parts; acetic acid, 15 parts; pyroligneous acid, 25 parts; lampblack (by measure), 20 parts; kerosene, 35 parts. Decoction of oak bark is placed in another retort (No. 2). The wood is first treated to vapor of No. 2, then to vapor of No. 1. For softer, fibrous material No. 2 may be omitted. The vapors absorbed are supposed to react on one another, forming a leather in the wood.
1868	73246	L. Harmeyer. A composition of tar, 1 barrel; rosin, 10 pounds; sulphuric acid, 2½ pounds; copperas, 10 pounds; salt, 6 pounds; alum, 6 pounds; lime, 60 pounds; carbon iron, 2 pounds; mixed by aid of heat.
1868	73565	S. Beer. Impregnation and removal of the sap by means of borax.
1868	77777	E. Spaulding. The timber is subjected to great longitudinal pressure to condense the cellular structure, rendering it more compact preparatory to seasoning by artificial heating.
1868	78514	F. Calkins. A method and apparatus for treating timber. Steam, together with the products of combustion, is admitted to the treating chamber; the timber being deprived of its moisture is subjected to oil vapors before cooling or exposed to the air.
1868	79554	C. M. Cresson. Employing heated air or gas to volatilize coal tar, etc., or a bath of carbolic acid, paraffin, or petroleum oils.
1868	81172	B. A. Yeager. Preserve by injection of copper sulphate and zinc oxide.
1868	83758	C. Brown. Process of <i>lapidifying</i> : Emery and carbonate of lime or iron are forced into the exhausted wood.
1868	84733	P. L. Cowling. The employment of dry, superheated steam alone to remove the moisture and with vaporized chemicals to impregnate the timber.
1869	86808	J. P. Bridge. A compound for preserving wood and leather: (1) By the action of hydrocarbon vapors, generated from rosin and salt; (2) subjecting wood to the vapors of ammonia sulphate to preserve it and render it incombustible.
1869	87226	Voorhees and Custis (reissue, 1869, No. 3451). Apparatus for seasoning and impregnating wood. The timber is run into a cylinder surrounded by cooling chambers and devices to regulate the air; below is a fireplace, by means of which oil vapors are generated in the chamber itself, it being partially filled with oil.
1869	88392	Kaunrodt and Thilmany. The use of barium chloride in combination with sulphate of copper.
1869	88926	H. Thayer. A filler of 1 part glue to 4 parts clay.
1869	89345	L. S. Robbins. Mode of preserving telegraph poles by filling borings near the ground with creosote oil and plugging.
1869	91848	D. W. Hunt. Method of impregnating lengthwise through the timber. Reissue 6848, 1876.
1869	94208	T. W. Heinnemann. Impregnation by infusing the pores with preservative by pressure of steam generated from a volatile liquid.
1869	94626	A. R. McNair. Process and apparatus: Coagulating albumen in the wood and extracting deleterious substances by means of steam. Condensing the steam to form a vacuum and removing the condensed steam and sap. Impregnating with antiseptic substance, cresote, or carbolic acid, lowering temperature to produce condensation, finally sealing the pores with resinous substances.
1869	94704	V. W. Blanchard. Perforation of the timber with holes filled with coal tar and pulverized stone or mineral to preserve the wood.
1869	94869	E. W. Clark. A preserving solution: Corrosive sublimate, 1 pound; copperas, 5 pounds; white vitriol, 5 pounds; water, 20 gallons.

American patents for preserving wood—Continued.

Year.	Patent No.	Remarks.
1869	95743	T. W. Heinnemann. Seasoning process by extraction of the sap and drying.
1869	95744	T. W. Heinnemann. Process and apparatus for preserving wood. The sap is exhausted and the wood warmed and pores opened by the application of steam; melted rosin is then run in and absorbed by the wood.
1869	95583	Hayford and Paul. Treating with vapors of paraffin, palm oil, and water and checking evaporation; and for the use of sodic silicate and ammonic carbonate.
1870	99186	H. Haupt. A process for drying wood or other fibrous matters by vacuum, caused by condensation of steam and impregnation by immersion or injection.
1870	100380	J. C. Day. An apparatus for drying and seasoning wood by means of a current of air.
1870	100608	E. J. De Smedt. Preservative compound: Richie mineral, 300-1,000 pounds, dissolved in 1,500 parts naphthalene dead oil and 400 parts pine tar, to which 1,500 parts benzol are added.
1870	101012	I. Hayford. An apparatus for treating wood by impregnating its pores with reagents, constructed so as to be able to vary or determine the amount of material injected into the wood.
1870	101691	W. H. Williams. A form of blocks for pavements.
1870	102665	R. A. Douglas. Subjecting timber to currents of hot air or boiling water and drying.
1870	102725	F. A. Stevens. A preserving apparatus.
1870	103105	A. Van Camp and M. Hodgman. Preserving paving blocks by soaking in pyroligneous acid, iron sulphate, and borax.
1870	{ 104916 } 104917	A. B. Tripler. Preserving by means of arsenic (or chloride) and salt. Railroad ties to be bored from end to end and filled with the compound. Reissued 1872; No. 483788.
1870	106625	A. J. Sheldon. Process of boiling wood in caustic lye to remove albumen and prepare it for impregnation.
1870	106647	A. Allen. Preventing decay of timber, building foundations, etc., by incasing in air-tight zinc cases.
1870	106927	J. K. Faus. A method of treating wagon fellies with oil.
1870	107620	B. R. Nickerson. Preserving and hardening wood by injecting a solution of sulphate of iron, a soluble arsenite, and a solution of lime.
1870	107854	H. H. Beach. Method of treating lumber with steam under pressure. Reissued 1871; No. 4384.
1870	107904	J. R. Hayes. Drying by means of superheated steam and impregnating by vapors of tannin and superheated steam; the tannin being supposed to combine with the gelatine and albumen, forming a leather.
1870	108659	E. Webb. The use of coal-tar distillate (carbolic acid) with wood-tar distillate; second, use of distillates with barium chloride; third, method of preserving by forming a longitudinal channel nearly from end to end with lateral leads through which the preservative liquid is introduced.
1870	108661	H. M. Westman. A <i>tar cement</i> for preserving by incasing.
1870	109027	F. Lear. An improvement on Hunt's apparatus, Patent No. 91848.
1870	109769	T. R. Sherry. A filler: Boiled linseed oil, 1 gallon; India rubber, 1 ounce; raw umber, 1 ounce; red lead, 1 ounce; sugar of lead, one-half pound; whiting, 3 pounds.
1870	{ 109872 } 109873	C. M. Cresson. Method of treating by liquids while being heated; second, treatment by shower of liquid and warm air.
1871	110652	W. Hayman. A composition to be applied with the brush: Coal tar, 40 gallons; naphtha or benzine, 10 gallons; soda silicate solution of 8° B.; lime, 62 ounces; copperas, 7 pounds.
1871	111045	Detwiler and Vinegilder. Impregnate with rosin, dissolved in naphtha, at high pressure and temperature.
1871	111511	P. E. Bombay. An apparatus for oiling fellies, etc.
1871	111784	W. H. Smyth. A cap to be fitted on the end of timber to inject preservative through end.

American patents for preserving wood—Continued.

Year.	Patent No.	Remarks.
1871	112136	E. W. Fowler. Method of impregnating blocks through the end by hydraulic pressure.
1871	113158	J. H. Gatling. Process of charging old field pine trees with rosin obtained from the tree itself by a method of girdling.
1871	113338	W. H. Pelton. A portable apparatus adapted for railroads, etc., for impregnating.
1871	113706	N. H. Thomas. Application of rosin oil, hot or cold, for preserving wood.
1871	115017	A. Bennington. A process of seasoning hubs by coating them with a viscous material, which will harden and completely close the pores.
1871	115446	E. Davee. Seasoning by covering or enveloping the timber in an air-tight covering of earth and applying heat to the exterior, which causes moisture to be evolved, and is absorbed by the earth.
1871	115784	A. H. Tait. Process of preserving by means of sulphurous acid combined with a base.
1871	115931	S. P. Brown. Process of "ironizing." Treat 12 hours with steam at 250° F., at normal pressure, then heat with solution and dry. Solution: Water, 90; sulphate of iron, 5; zinc chloride, 2; carbolic acid, 2; salt 1.
† 1871	115946	J. W. Fielder. Improvement in Robbins's apparatus for treating wood.
1871	116274	Constant and Smith. An apparatus for seasoning and preserving by means of heat.
1871	116969	F. Lear. Process of seasoning, coloring, and preserving. Hot air is drawn and forced through the wood lengthwise to dry and season it, then coloring and preservative solutions similarly charged.
1871	118245	J. Jones. Preservative compound of asphaltum dissolved in turpentine, combined with a varying quantity of carbolic acid.
1871	118528	J. F. Gyles. An improved form of block for pavement.
1871	120009	R. Sutphen. Compositions for preserving wood, of asphaltum, coal tar, rosin, and Japan, or coal tar, rosin, and Japan.
1871	121141	J. G. Voorhees. Improved treating tank for impregnating by vapors, etc.
1872	123009	Fawcett and McGovern. An impregnating composition: Dead or petroleum oil, 1 gallon; crude sulphur, 1 pound; rosin, 1 pound; carbolic acid, $\frac{1}{4}$ pound.
1872	123467	Feuchtwanger. A process of applying sodic silicate, hot, after removal of the albumen, then pyroligneous acid and lime. By this deposits of calcic and sodic acetates and silicates are obtained together with tarry matters.
1872	124080	W. H. Pelton. Invention of an impregnating apparatus.
1872	124358	— Holmes. Preserving preparation of rosin and asphaltum dissolved in cold naphtha.
1872	124402	Waterbury process. Injection of salt, then of dead oil to harden and preserve lumber.
1872	{ 124419 } { 124420 }	S. L. Cole. Use of pine distillate as preservative.
1872	126653	N. Surges. Whiting, 2 pounds; white soapstone, 1 pound; alum exsic., $\frac{1}{4}$ pound; boiled linseed oil, 2 pounds; Japan, 2 pounds; turpentine, 1 pound.
1872	127482	T. Hayford. Process of steaming, treating with hot air under pressure, and impregnating.
1872	128387	J. F. Gyles. Method of drying, applying pressure normal to the fiber.
1872	129503	P. Welch. A composition to be applied to wood as coating or saturating. Asphalt from coal tar, heavy oil of coal tar, soda ash, and lime.
1872	130562	L. S. Gibson. Fireproofing composition of alum, lead acetate, and a silicate.
1872	132584	W. H. Jones. Process of treating paving blocks by boiling 5 to 10 minutes in distillate of coal tar of 10° B.
1872	134133	E. J. Eames. Preserving wood by carbolic or cresylic acid, by which the wood is soaked, painted, or impregnated by pressure.
1873	138914	J. Mueller. Impregnation with barium phosphate by first charging with a 7 per cent. solution of sodic phosphate, then with a 13 per cent. solution of baric chloride
1873	140520	H. R. McGonegal. An improved treating tank, mounted on trunnions to facilitate charging and discharging.

American patents for preserving wood.—Continued.

Year.	Patent No.	Remarks.
1873	142446	J. B. Dittenhaur. A filler : 1 gallon linseed oil, 4 pounds cornstarch, 4 ounces magnesia, 1 pint spirits of turpentine, 1 pint Japan drier, 1 ounce white wax.
1873	142453	L. S. Fales. A preservative composition : 10 gallons petroleum, 10 gallons sludge tar, 1 gallon linseed oil, 5 pounds slaked lime. Boil 4 to 5 hours, add 10 pounds rosin, 1 pound gum shellac, 3 gallons dead oil. Immerse the timber for two hours at 400° F.
1873	143347	J. Oliver. Treatment with zinc sulphate and alum
1873	144948	C. E. Bradley. A filler of india rubber, shellac, litharge, and sugar of lead.
1873	145859	J. O. Froshang. Preserving and coloring wood to imitate slate, boiling in solution of ferrous sulphate, alum, salt, and extract of logwood.
1874	148630	J. C. Stead. Apparatus for preserving wood.
1874	150841	F. Dufour. Impregnate with solution of tannin of lentiscus, then with acetate of iron.
1874	151825	O. S. Beale. Fireproofing composition of coal tar, boiled linseed oil, dead oil, sodium bicarbonate, salt, calcic chloride, and ferrous sulphate.
1874	152620	J. A. Draper. Impregnating with water, lime, and rosin.
1874	153515	R. W. Archie. Charring, then filling crevices with sand, and coating by coal tar.
1874	154191	T. Jones. Use of tungstate of soda to prevent dry rot.
1874	154767	J. M. Reid. Preserving by applying hydro-carbon or other inflammable matter and charring, with or without alum or other uninflammable material.
1874	155788	Albert Brisbane. Preserving paving blocks by saturating with coal tar and afterward subjecting to heavy pressure.
1875	160010	Dorr & Seyfert. A filler to be applied by brush and polished : Collodion (4), gum shellac (3), gum sandarach (1).
1875	160846	G. B. Smith. Apparatus to impregnate by pressure through ends of timber and arrangement of apparatus in nests.
1875	164786	P. Werni. Preservation of potassic cyanide, glue and zinc sulphate.
1875	165758	L. S. Robbins. Process of vulcanizing—subjecting the wood in close receivers to heat and air or gaseous pressure, whereby the evaporation of the sap is prevented and it is coagulated in the wood.
1875	170533	J. Dewitt. A fireproofing composition of coal tar, lampblack, gum copal, turpentine, salt, lye, and hydraulic cement.
1875	171135	J. Huntington. A cap, to be used in impregnating wood through the end by pressure.
1876	172501	M. Robling. A process of treating wood for shoe soles, etc., by combined agency of steaming and rolling, to increase its flexibility.
1876	172534	N. Wheeler.
1876	174914	R. Lockwood. Boiling, then treating to free from water by pressure from sides, injecting glue, and drying by pressure.
1876	175329	A. T. Bleyley. A coating to be applied to burial cases—glue, alum, salaratus, saltpeter, salt, potassic, bichromate, and water, applying a second coating of glue and bichromate, and a third of alcohol, shellac, and bichromate.
1876	175621	P. O'Brien. Preparing surfaces of wood for carriages, by oiling and driers.
1876	177770	W. Thilmany. Apparatus for impregnating with antiseptics.
1876	181651	F. Dixon. Method of treating wood casks or vessels, with hydrochloric or sulphuric acid, then with salicylic acid and soda bisulphate.
1876	184441	T. Cabot. Alternate treatment with copper sulphate and calcium phenate and cresate.
1876	184618	J. Hawksley. Process of filling and finishing hard woods, by successive coatings of a filler and finisher. Filler : Whiting, 1½ pounds ; raw linseed oil, 1 gallon ; Japan drier, ½ teaspoonful ; turpentine, 1 gill. Finisher : Japan drier, 1 gill ; turpentine, 1 gill ; varnish, ½ gill.
1876	185058	H. Akerhielm. Compound of iron sulphate, salt, and water.
1877	186881	W. J. Ryckmann. Fireproofing solution, of borax, alum, and sal ammoniac.

American patents for preserving wood—Continued.

Year.	Patent No.	Remarks.
1877	191257	Reget <i>et al.</i> Saturating with a soluble lead salt, which becomes insoluble on contact with the fiber.
1877	194773	T. Hayford. Improvement in apparatus and process for impregnating wood.
1877	194916	A. Jamieson. Fireproofing compound of water glass, oxide of zinc, and ammonia.
1877	197200	F. A. Howig. Method of softening wood, etc., for bottle stoppers, etc. Treating with a strong alkali solution to remove sap, steaming, and hot water, and saturate with paraffin and wax, or wax alone.
1878	199001	G. B. Smith. Preserving and fireproofing by boiling for 48 hours in aqueous solution of zinc sulphate or chloride, ferrous sulphate, and alum.
1878	201022	J. G. La Fonte. Treating with carbolic acid, glycerin, shellac, and asphalt, to render the wood flexible.
1878	202678	W. Thilmany. Treatment with zinc sulphate and barium chloride.
1878	203304	N. Wheeler. A filler of corn meal, linseed oil, and Japan varnish.
1878	208649	A. B. Tripler. Improvement in curing and drying woods by heating by live steam in a jacket, then introduce superheated steam at a pressure of 100 pounds, and finally air to remove moisture.
1879	215600	W. T. Garret <i>et al.</i> Introduction of antiseptic into piles near the bottom by holes which may be plugged.
1879	216589	Wellshouse <i>et al.</i> Use of zinc chloride and gelatin and subsequent injection of tannin.
1879	218569	C. H. Bithorn. Impregnating with copper sulphate and benzoic acid by soaking, pressure, or vital suction.
1879	218624	W. D. Grimshaw. Apparatus for treating wood by subjecting to rotary motion to secure uniform results, etc.
1879	219377	Oliver App. Preservative composition: boiled linseed oil, 1 gallon; charcoal, 3 quarts; whiting, 1 pound; Japan drier, 1 gill.
1879	221308	T. G. Hojer. A filler: of boiled linseed oil 70 parts, turpentine 15, manganese dioxide 5, manganese sulphate 5, litharge 5, and coloring matter.
1880	226844	G. A. Fudickar. Process of saturating ebony with oil and gradually raising the temperature to produce imitation rubber.
1880	227121	T. A. Miller. Apparatus to wash and oil wheels.
1880	231419	J. D. Francks. Treatment of timber with lime and urine in heated state.
1880	{ 231783 231784 }	H. Flad. Method of seasoning wood by placing one or more timbers in a closed vessel supplied with dried air at ordinary pressure and exhausting from the end or ends.
1880	236065	G. H. Müller. Treating with barium chloride and sodium sulphate.
1881	238341	W. W. Bunnell. Preserving by compound of boiled linseed oil, pulverized charcoal, and nitre.
1881	239033	Dixon and Card. Impregnating by lead chloride in hot aqueous solution.
1881	241407	D. F. Noyes. A wood-drying apparatus.
1881	241686	H. W. Mattick. A filler of shellac, gum kauri, red lead, linseed oil, etc.
1881	243062	J. H. Conne'ly. Impregnation with ammoniac sulphate.
1881	244324	B. Smith. Preservative of coal tar (8), crude carbolic acid (1), crude pyroligneous acid (three-fourths), mix and heat <i>not</i> to boiling, soak wood until saturated.
1881	245845	G. Lukins. A preservative and fireproofing composition, to be introduced into borings in posts and allowed to disseminate.
1881	246762	E. Hagen. Solution to be forced in at pressure of 100 pounds. Solution: Gypsum, 1 part; zinc chloride, 2 parts; water, 97.
1881	246889	C. H. Kuhn. A filler of soap-maker's waste (washed and dried) and oil.
1881	247234	— Andrews. A combination of 3 parts "still bottoms" (petroleum residues) and 1 part creosote oil.
1881	247602	S. B. Boulton. Subjecting timber in closed vessels to action of creosote oil, or similar substance, at temperature about 212° F. below the vaporizing point, under pressure.
1881	247947	J. W. Putnam. Apparatus for treating timber to preserve it.

American patents for preserving wood—Continued.

Year.	Patent No.	Remarks.
1881	248029	F. Donnet. A filler of Japan drier, benzine, silver white, plaster Paris, lead sulphate, acetic acid, and coloring matters.
1881	248334	H. W. Mattick. A filler of linseed oil, kauri, Japan varnish, English cliffstone, Paris white, and a liquid carrier of red lead, litharge, sugar of lead, zinc, sulphate, and turpentine.
1881	249953	H. E. Kreuter. A portable impregnating apparatus.
1881	249856	S. R. Percy. Impregnation by picric acid or picrates and resinous gums, pitch or coal tar, dissolved in some solvent as benzine.
1881	251346	W. C. Bruson. A composition of powdered sulphur, lime, salt, and charcoal, to be placed in boring to protect timber.
1881	254274	J. P. Card. Impregnating with mineral or soluble salt, driven in from outside and coated with coal tar.
1882	254918	L. D. Mott. A covering for wood or metal of gas tar, sulphur, salt, yellow ocher, and paint.
1882	257332	T. Gurney. Fireproofing compound: Infusible earth, silica, asbestos, fireclay, and dilute sulphuric acid.
1882	259030	J. C. Marshall. Solution to be applied hot to prevent shrinking and warping. Linseed oil, 1 gallon; salt, 4 ounces; niter, 2 ounces; turpentine, 1 pint.
1882	261405	W. Taggart. Method of preserving piles: By boring longitudinally, then introducing steam or hot water under pressure, and finally forcing in preservative solution.
1882	263884	W. N. Horton. A form of pile to withstand attacks of worms, etc.
1882	266092	R. G. Bürstenbinder. A double process by zinc sulphate and <i>calcic</i> chloride.
1883	271995	Suillot and David. Impregnate with saccharine solution of a salt, or base combined with boracic, tungstic, phosphoric or silicic acids, for fireproofing.
1883	273861	J. Loomis. Seasoning and preserving solution: Lime, ammonia, and soda, in which the timber is soaked.
1883	277810	L. N. Teachman. Impregnating solution: Zinc and <i>calcic</i> sulphates, potassic chlorate, and silicate.
1883	282395	J. D. Stanley. Apparatus for charring timber.
1883	284653	J. D. Mott, jr. Composition to render wood and metal fire and water proof: Gas tar, yellow ocher, sulphur, ironclad mineral paint, and rosin, with or without salt.
1883	285087	G. S. Valentine. Method and apparatus for impregnating timber to a given height.
1883	286117	Clothier <i>et al.</i> Fireproofing compound: Whiting, iron ore, oxide of zinc, lampblack, coach, body varnish, turpentine Japan, and turpentine.
1883	287351	J. F. Walter, jr. Process of subjecting the timber to the absorbent action of salt, whereby the sap is prevented from coagulating or hardening on the surface before all the fluids have escaped.
1883	288269	D. H. Smith. Fireproofing compound: Gas tar, soluble glass, asbestos, Winter's metallic paint, alum, borax, zinc oxide, and salt.
1883	288621	W. S. Chandler. Fireproofing compound: Coal tar, 1 barrel; ironclad paint, 40 pounds; sulphur, 40 pounds; Venetian red, 20 pounds; salt, 15 pounds; alum, 10 pounds; litharge, 10 pounds; asphaltum, 10 pounds; rosin, 20 pounds.
1883	289022	J. H. Nolan. Fireproofing compound: Asbestos, $\frac{1}{2}$ – $\frac{3}{4}$; marl, etc., $\frac{1}{2}$ – $\frac{3}{4}$; saturate with sodic silicate or <i>calcic</i> chloride, alum, borax, niter.
1883	289262	K. A. Hohenstein. Fireproofing compound or paint: One gallon sodic silicate, 3 gallons milk, 3 pounds chalk.
1884	291176	L. Feldin. Fireproofing compound: Asbestos, 1 pound; sulphate of iron, 3 pounds; sulphuric acid, 1 pint; ammonia chloride, one-half pound; arsenic sulphide, 1 pound.
1884	293955	H. C. Dorr. Preservative compound: Dead oil, 50 gallons; sulphur, 25 pounds; paraffin, 25 pounds; heat to 270° F.
1884	294676	W. W. Robinson. Fire and water proofing composition: Immerse in water solution of salt (6), lime (6), copperas (2), paint (2), sulphur (2), at boiling heat. Then coat with paint (6), whiting (3), glue (2), lime (6), in linseed oil.

American patents for preserving wood—Continued.

Year.	Patent No.	Remarks.
1884	296324	M. O. Fisher. Fireproofing composition: Coal tar, 1 barrel; yellow ocher, 30 pounds; mineral paint, 37 pounds; sulphur, 37 pounds; talc, 20 pounds; mix and heat to 260° F. one hour before using.
1884	297568	S. Cabot, jr. Staining and preserving solution: Rectified creosote or any distillate of coal tar between 125° and 200 C., 15 per cent. pigment, 10 per cent. drying oil.
1884	302742	M. Kunz. A filler: Alcoholic solution of glue and benzine or turpentine.
1884	304911	C. W. Colony. Fireproofing composition to be applied hot: One gallon coal tar, 4 pounds pulverized stone or slate, 1 pound salt, 1 pound red or white lead, one-half pound alum, one-half pound Venetian red, one-half pound asbestos, 1 pound rosin, one-half pint linseed oil.
1884	308174	Gunenez and Yrigoyen. A fireproof paint: Infusion of 31 grammes holly bark, 2 grammes salt, 140 grammes zinc sulphate, 125 grammes ammonia chloride, 125 grammes alum, 2 grammes fish glue.
1885	{ 310880 313913 }	Collings and Pike. Apparatus for treating wood with vapors.
1885	313912	J. B. Blythe. Apparatus and method of charging wood by steam, etc.
1885	316961	Hansen and Smith. Creosoting apparatus.
1885	317125	H. Hales. A filler of powdered soapstone, glue, and carrier, as linseed oil or Japan varnish.
1885	317129	Hansen and Smith. Method of charring and saturating with creosote oil.
1885	317440	J. P. Card. Impregnating with oil and then driving it in by some antiseptic fluid.
1885	318935	S. F. Woodhouse. A filler of China clay, corn starch, linseed oil, turpentine, varnish, and Japan drier.
1885	319792	Coppernoll and Brandow. A filler of boiled linseed oil, corn starch, gum shellac, red lead, pulverized raw umber, plaster or gypsum, and fluid vehicle.
1885	322280	J. F. Greenwood. Fireproofing compound: Fifty gallons coal tar, 5 pounds water glass, 8 pounds asbestos, 12 pounds salt—mix; add 5 pounds red lead, 8 pounds litharge, 1 gallon asphalt, 5 pounds Venetian red.
1885	322819	Hansen and Smith. Wood preserving apparatus.
1885	329799	J. H. Young. Apparatus for impregnating by pressure.
1885	329973	R. Janczos. Fireproofing: Impregnate with borax and magnesia sulphate; dry coat with mixture of washed clay, glass; sheath with paper or fabric impregnated with borax, and apply to sheathing a solution of ammoniac and calcic sulphates in water.
1885	332093	J. A. Matthieu. Apparatus to preserve ties, etc.
1885	333204	J. Dolbeu. Apparatus for steaming piles.
1886	336718	Horner and Hyde. Water proofing and preservative compound: Resin, paraffine wax, and benzine.
1886	343906	W. H. Keller. Fireproofing compound: Ten to 20 pounds mineral wool, 5 pounds vulcanized India rubber, 1 gallon Japan drier, 35 gallons coal tar, 10 pounds litharge, 2 quarts sulphuric acid, 10 pounds iron oxide, 2 gallons turpentine, 5 pounds yellow ocher, 5 pounds Venetian red, and naphtha.
1886	344261	J. C. Emerson. Fireproofing compound: Fifty pounds potassa in 10 gallons water, add 30 gallons coal tar, and stir in 60 pounds hydrochloric acid.
1886	352216	H. Aiken. Use of naphthaline as preservative.
1887	359384	Birsley and Finch. Preservative: Lime, 1 barrel; crude petroleum, 4 quarts; oil of tar, 1 quart; ammonia, 1 quart; impregnated by steeping or painting.
1887	360947	S. B. Boulton. Preserving by impregnating with metallic salt, with or without carbolic or cresylic acid, and expelling the water by subjecting it to bituminous bath of creosote or similar compound.
1887	{ 361193 361195 }	J. D. Stanley. Charring devices.
1887	361196	H. F. Watson. Fireproofing composition: Lead acetate, calcic acetate, salammoniac, each 2 parts, ammoniac sulphate, 4 parts; aluminum sulphate, 1 part.

American patents for preserving wood—Continued.

Year.	Patent No.	Remarks.
1887	374208	J. A Sewall. Treating with boracic acid, then with lime water.
1888	378459	C. W. Parker. Inclined holes are bored in the posts at level of ground or between high and low water marks, a preservative placed in, and covered with (patent) cap and rubber seal.
1888	380593	Zuarante and Escalonne. Preservative solution of lead and alumina acetate, lead pyrolignite, and glue.
1888	380820	H. L. Ricks. Method of preserving timber in <i>salt</i> water by keeping it soaked in <i>fresh</i> water under pressure, fresh water being introduced into an interior channel and passed outward through the wood.
1888	381682	P. H. Dudley. Apparatus to impregnate timber by applying force and suction at the opposite ends.
1888	386999	J. C. Mallonee. Process : Steam is used to open the pores and drying by high-pressure steam. The chamber is then filled with the liquid and heated, whereby it expands and is forced into the wood.
1888	387375	G. Speiz. Heating timber for 10 hours in bath of 10 pounds sulphur, 1 pound mercury per 1,000 gallons water.
1888	391209	Taylor <i>et al.</i> Composition to preserve wood and destroy scent by sprinkling : Arsenic, 3 ounces ; copper sulphate, 1 ounce ; soda, 1 ounce ; niter, one-half ounce ; sulphur, one-half ounce ; ammonia chloride, one-half ounce to 30 gallons water.
1888	391261	B. F. McIntyre. Fireproofing composition : Sulphoricinoleate of ammonia, and borax or borate of soda, ammonia chloride, alum, niter, and sodic silicate in equal portions.
1888	391327	B. F. McIntyre. Fireproofing compound : Sulphoricinoleate of ammonia, 2 ; ammonia carbonate, 2 ; crude tartar, 1 ; soda acetate, 1 ; ammonia chloride, 7.
1889	398619	W. Iddings. Preserving and hardening : Boil in lye, 2 ; lime, 1 ; alum and salt (saturated solution) ; iron ore, 2 ounces ; water, 2 gallons. Then immerse in hot solution of flaxseed oil, 1 pint ; petroleum oil, 1 gallon ; rosin, 1 pound ; red lead, 4 pounds.
1889	398666	W. Youngblood. The dried wood is saturated with niter, red sanders (California redwood) in water. It is then saturated in bath of paraffin.
1889	399196	S. E. Hasker. Vulcanizing by introducing heated air into vessel under pressure.
1889	403144	T. H. Sampson. Process of preventing warping and twisting of wood by treating with heat, etc., and impregnation by basic metallic salt and drying by vacuum, etc.
1889	403449	H. Stokes. Preservative of crude petroleum, 10 ; rosin oil, 3 ; oil of tar, 1 ; salt, 1.
1889	404566	P. H. Dudley. Preserving by filling hole with antiseptic acid then inserting spike.
1889	{ 405907 } 405908	J. W. Putnam. Use of rosin creosote, pine wood oil.
1889	404302	J. W. Putnam. Use of rosin oil, petroleum, and creosote oil.
1889	410467	J. W. Tamplin <i>et al.</i> Apparatus for boiling fellies.
1889	414161	A. J. Goodwin. Impregnate with copper sulphate, 2 ounces ; Rochelle salt, 2 ounces ; potash, $\frac{1}{2}$ ounce ; water, 1 gallon. If the wood is old, first inject 4 ounces glucose, 1 gallon water. Copper subcarbonate is deposited by reaction of glucose and CO ₂ on the copper.
1889	{ 414246 } to 414249	G. Phillips. Preservatives by means of asphalt, lime, etc.
1890	419858	C. T. Lee. Treat by immersion in solution of resinate of glycerine and naphtha with heat.
1890	419582	J. P. Card. Kyanizing solution : Corrosive sublimate, 1 ; zinc chloride, 20 ; water, 979.
1890	430055	W. C. Andrews. Preserving by heating 200° to 300° under pressure, then 300° to 400° 4 to 12 hours.
1890	430068	O. Chanute. Applying preservative of arsenic, corrosive sublimate, etc., to joints and sealing them.

AMERICAN EXPERIMENTS WITH COPPER PRESERVATIVES.

(Trans-American Society Civil Engineers, 1885.)

No.	Locality.	Year.	Method.	Material.	Exposure.	Result.	Authority.
1	Chile, S. A...	1857	Boucherie ..	Poplar ties....	Railroad track.	Favorable ..	W. W. Evans.
2	Cleveland, O..	1870	Thilmany...	Ties	do	Favorable to 1875.	J. R. Conrad.
3	Washington, D. C.	1872	do	Paving blocks	Laboratory.	Unfavorable	W. C. Tilden.
4	Pensacola,	1874	do	Live oak.....	Teredo ...	Failure	W. H. Varney.
5	Charleston, S. C.	1875	do	Pine blocks...	do	do	Q. A. Gilmore.
6	San Francisco	1876	do	do	do	do	C. S. Stewart.
7	Milwaukee ...	1876	do	do	Pavement	Favorable to 1882.	Schlitz Brewery Company.
8	Norfolk, Va ..	1876	do	Hackmetack..	Teredo ...	Failure	P. C. Asserson.
9	Charlestown, Mass.	1877	do	Various.....	Laboratory.	Favorable ..	J. F. Babcock.
10	Wabash R. R.	1877	do	Ties.....	Railroad track.	Unfavorable	R. A. Houghton.
11	do ...	1878	do	do	do	do	W. S. Lincoln.
12	N. Y., Pa. & O. R. R.	1879	do	do	do	do	C. Latimer.
13	Lake Shore & M. S. R. R.	1879	do	do	do	do	R. A. Houghton.
14	Cleveland & Pittsburg R. R.	1879	do	do ...	do	do	C. Latimer.
15	Charlestown, Mass.	1879	do	Spruce plank.	Sidewalk..	Success to 1882.	S. G. White.
16	B. and O. R. R.	1879	do	Ties	Railroad track.	Too recent..	J. T. Randolph.
17	Hudson River R. R.	1869	Hamar	do	do	Success.....	E. W. Vanderbilt.
18	St. Louis.....	1882	Fladd.	do	do	Too recent..	H. Fladd.

AMERICAN EXPERIMENTS IN BURNETTIZING.

1	Lowell Canal Co.	1850	Bethel.....	Various.....	Canal.....	Unfavorable	J. B. Francis.
2	Cambridge R. R.	1855	do	Spruce ties ...	Railroad track.	Favorable ..	K. S. Chaffee.
3	Vermont Central R. R.	1856	do	Hemlock.. ...	do	Success to 1882.	J. W. Hobart.
4	Boston Wharf	1857	do	Spruce plank.	Wharf....	Sound to 1872.	C. Page & Co.
5	Middlesex R. R.	1857	do	Spruce sleepers.	Horse railroad.	do	C. W. Palmer.
6	South Boston R. R.	1857	do	do	do	do	R. Johnson..
7	Boston and Albany R. R.	1860	do	Spruce ties ...	Bridge floor.	Favorable ..	E. S. Philbrick.
8	Chicago, Rock Is'd & Pacific R. R.	1860	do	Timber.....	Howe truss.	Success to 1882.	H. Riddle.

American experiments in burnettizing—Continued.

No.	Locality.	Year.	Method.	Material.	Exposure.	Result.	Authority.
9	Erie Railway.	1861	Bethel	Timber ..	Bridge....	Unfavorable	W. B. Coffin.
10	Ohio & Mississippi R. R.	1862	do	do	do	Doubtful ...	T. S. Sedgwick.
11	P. W. & D. R. R.	1863	... do	Ties	Railroad track.	Abandoned.	I. Hinckley.
12	C., R. I., & P. R. R.	1866	do	do	do	Success....	M. Alexander.
13	Havre de Grace.	1866	do	Timber	Bridge....	Injured strength.	E. Larkin.
14	Phila. & Reading R. R.	1867	do	Ties	Railroad track.	Hard and brittle.	W. Lorenz.
15	Lehigh & Susquehanna.	1867	do	do	do	Success to 1882.	L. L. Brick.
16	Union Pacific R. R.	1868	do	Cottonwood ..	Ties	Abandoned.	L. S. Bent.
17	Long Island R. R.	1868	do	Stringers	Bridge piles.	Failure	F. S. Gannon.
18	Philadelphia..	1868	... do	do	Horse-car road.	.....	G. S. Gandy.
19	Washington, D. C.	1872	do	Spruce	Pavement.	Failure	J. A. Partridge.
20	do	1872	do	do	Laboratory.	Zinc washed out.	W. C. Tilden.
21	St. Louis Bridge.	1879	Weilshouse.	Gum blocks ..	Pavement.	Favorable '83.	C. S. Smith.
22	do	1879	do	Pine stringers.	Bridge.	do	C. S. Smith.
23	St. L., I. Mt. & So. R. R.	1879	do	Ties	Railroad track.	do	H. Constable,
24	Ill. & St. L. R. R.	1880	do	do	do	do	C. H. Sharman.
25	A. T. & S. F. R. R.	1881	do	do	do	do	A. A. Robinson.
26	St. Louis.....	1879	do	Gum block ...	Pavement.	do	H. Constable.
27	Norfolk, Va..	1880	Thilmany...	Pine piles.....	Teredo ...	Failure	P. C. Asserson.
28	Chicago & Alton R. R.	1880	do	Ties	Railroad track.	Too recent..	W. F. Merrill.
29	Erie R. R.	1882	do	do	do	do	O. Chanute.
30	St. Louis	1883	Zinc gypsum	do	do	do	T. Plate.

AMERICAN EXPERIMENTS IN KYANIZING.

1	Northern Central R. R.	1838	Steeping....	Chestnut ties.	Railroad track.	Favorable to 1849.	T. J. Cram.
2	Ft. Ontario, N. Y.	1839	do	Hemlock	Fortifications.	Partial success.	W. H. Judson.
3	Chesapeake & Ohio R. R.	1840	do	Oak ties	Railroad track.	Favorable to 1854.	W. D. Whitcomb.
4	Alexandria ...	1840	do	Timber	Bridge....	Success to 1862.	W. R. Hutton.
5	D. & H. Canal.	1842	do ..	Rope	Inclined planes.	Abandoned.	J. Archbald.
6	Balto. & Ohio R. R.	1842	do	Ties.....	Railroad track.	Not encouraging.	J. L. Randolph.

American experiments in kyanizing—Continued.

No.	Locality.	Year.	Method.	Material.	Exposure.	Result.	Authority.
7	Old Colony R. R.	1845	Steeping...	Ties	Railroad track.	Did not pay.	I. Hinckley.
8	East. Mass. R. R.	1846	Pressure....	do	do	Cost too much.	H. Bissell.
9	Prov. & Worcester R. R.	1847	Steeping....	do	do	Did not pay.	I. Hinckley.
10	Lowell Canal Co.	1848	do	Timber	Bridges...	Continued success.	J. B. Francis.
11	N. Y. Cent. R. R.	1849	do	Ties	Railroad track.	Favorable to 1859.	J. F. Wilkinson.
12	Phila. & Reading R. R.	1800	do	Pine timber ..	Bridges...	Success....	J. D. Steele.
13	Fitchburg R. R.	1853	do	Joists	Shop-floor	Failure	J. Adams.
14	Blackstone Bridge.	1854	do	Pine timber ..	Bridges...	Success....	W. H. White.
15	Boston & Providence R. R.	1856	do	Ties	Railroad track.	Unfavorable	G. F. Folsom.
16	Eastern Mass. R. R.	1881	do	do	do	Too recent	H. Bissell.

AMERICAN EXPERIMENTS IN CREOSOTING.

1	Phila. & Reading R. R.	1854	Coal tar	Ties	Railroad track	Failure . .	W. Lorenz.
2	Taunton, Mass.	1865	Bethel	Piles.....	Teredo ...	Favorable ..	I. Hinckley.
3	Callowhill bridge, Phila.	1868	Boiling	Plank.....	Bridge floor.	Failure	R. Hering.
4	Chicago, Burlington & Quincy R. R.	1868	Seely	Ties	Railroad track.	do	T. H. Perry.
5	Chicago, Rock Island & Pacific R. R.	1868	do	do	do	do	E. H. Johnson.
6	St. Clair Flats.	1868	do	Pine timber ..	Canal....	do	F. Harwood.
7	Wilmington, Cal.	1871	Robbins	Piles.....	Teredo ...	do	C. R. Sears.
8	Washington, D. C.	1872	do	Paving blocks	Laboratory.	Unfavorable	W, C. Tilden.
9	do	1872	Seely	do	do	Favorable ..	Do.
10	Pittsburg....	1872	do	do	Street	do	A. Dempster.
11	Washington, D. C.	1872	Constant & Smith.	do	Laboratory.	Unfavorable	W, C. Tilden.
12	do	1872	Detwiler....	do	do	do	Do.
13	do	1872	Thomas	do	do	do	Do.
14	New Orleans.	1872	Boiling	do	Paving ...	Success....	T. Forstall.
15	East River Bridge.....	1872	Steaming...	Plank.....	Caissons..	do	E. Collingwood.
16	Boston....	1872	do	do	Floor ...	do	Blake Manufacturing Company.
17	Cleveland	1873	Seely	Blocks	Paving .	Favorable ..	H. G. Wilson.
18	U. S. S. <i>Vandalia</i> .	1873	Steaming...	Timber	Ships	do	F. L. Fernald.

American experiments in creosoting—Continued.

No.	Locality.	Year.	Method.	Material.	Exposure.	Result.	Authority.
19	Dry Tortugas.	1873	Steaming...	Gun platform.	Fortifications.	Failure.....	W. H. Hener.
20	Titusville.....	1873	Petroleum..	Ties.....	Railroad tracks.	Various.....	O. Chanute.
21	Rochester.....	1873	...do.....	Machines.....	Weather..	Favorable..	J. M. Harris.
22	Galveston.....	1874	Steam.....	Pine blocks..	Pavement.	Failure.....	G. M. Hartwick.
23	...do.....	1874	...do.....	...do.....	Stable.....	Success.....	W. E. Gregory.
24	...do.....	1875	...do.....	Piles.....	Teredo...	Partially successful.	P. M. Temple.
25	N. O. & Mobile R. R.	1876	...do.....	...do.....	...do.....	Success.....	J. W. Putnam.
26	...do.....	1876	...do.....	Timber.....	Bridge.....	...do.....	Do.
27	B. B. R. R.....	1876	Hayford....	Ties.....	Railroad track.	...do.....	E. R. Andrews.
28	New York.....	1876	Webb.....	...do.....	...do.....	Failure.....	W. Ludlow,
29	Delaware Bay.	1878	Steaming...	Pine blocks..	Teredo...	Success.....	W. Lorenz.
30	Phila. & Reading R. R.	1878	...do.....	Ties.....	Railroad track.	Success to 1882.	A. F. Perkins.
31	Boston.....	1878	...do.....	Posts.....	In earth..	Favorable..	W. W. Shippen.
32	Hoboken.....	1878	...do.....	Ties.....	Railroad track.	...do.....	Do.
33	Hoboken.....	1879	...do.....	Piles.....	Teredo....	...do.....	R. E. Pettit.
34	Trenton.....	1879	...do.....	Planks.....	Bridge.....	...do.....	T. Forstall.
35	New Orleans..	1880	...do.....	Ties.....	Railroad track.	...do.....	M. G. Howe.
36	Houston.....	1880	...do.....	...do.....	...do.....	...do.....	G. Bonscaren.
37	New Orleans..	1882	...do.....	Piles.....	Bridge.....	...do.....	J. W. Putnam.....
38	Charleston, S. C.	1882	...do.....	...do.....	Wharf.....	...do.....	Do.
39	Pensacola and Atlantic R. R.	1882	...do.....	...do.....	Bridge.....	...do.....	Do.

AMERICAN EXPERIMENTS—MISCELLANEOUS.

1	Chestnut St ..	1839	Earles.....	Hemlock blocks.	Paving...	Failure.....	S. V. Benét.
2	Watervleit Arsenal.	1840	...do.....	Oak timber..	Gun-carriages.	...do.....	Do.
3	Delaware and Hudson Canal.	1840	...do.....	Rope.....	Fungus pit.	Favorable..	Do.
4	Phila. and Columbia R. R.	1840	Lime bath..	Pine stringers.	Railroad track.	Unfavorable	M. Coryell.
5	Boston and Providence R. R.	1844	Iron sulphate.	Ties.....	...do.....	...do.....	I. Hinckley.
6	Belvedere R. R.	1850	Salt.....	Hemlock.....	...do.....	...do.....	M. Coryell.
7	Rochester.....	1852	Payenizing	Ties.....	...do.....	...do.....	T. Hilliard.
8	Germantown, Ind.	1855	Charring...	Fence posts..	Fence.....	Favorable '79	G. McGrew.
9	Pottsville, Pa..	1857	Pyrolig. of iron.	Timber.....	Railroad sills.	Unfavorable	H. K. Nichols.
10	Erie R. R.....	1858	Boring.....	...do.....	Bridges...	Favorable..	H. D. V. Pratt.

American experiments—miscellaneous—Continued.

No.	Locality.	Year.	Method.	Material.	Exposure.	Result.	Authority.
11	Galveston ...	1867	Casing.	Piles.	Bridge.	Failure.	W. H. Smith.
12	New York.	1868	Beerizing.	Lumber.	Signs.	Doubtful.	S. Beer.
13	Wyoming.	1868	Natural soil.	Ties.	Railroad track.	Preserved.	J. Blinckinsderfer.
14	Chicago.	1870	Formanizing	Timber.	Steamboat	Favorable '79	M. B. Brown.
15	Ill. Cent. R. R.	1871	do.	Ties.	Railroad track.	Failure.	L. P. Morehouse.
16	St. Louis.	1871	do.	Shingles.	Roof.	do.	F. de Funiak.
17	Memphis and Charleston R. R.	1871	do.	Ties.	Railroad track.	do.	Do.
18	Washington, D. C.	1871	Tripler.	Paving blocks	Laboratory.	do.	W. C. Tilden.
19	do.	1872	Samuel.	do.	do.	do.	Do.
20	do.	1872	Taylor.	do.	do.	do.	Do.
21	do.	1872	Waterbury.	do.	do.	do.	Do.
22	do.	1872	Iron sulphate.	do.	Pennsylvania.	do.	J. A. Partridge.
23	do.	1872	Zinc sulphate.	do.	East street.	do.	Do.
24	do.	1872	Petroleum.	do.	16th street.	do.	Do.
25	New Orleans & Mobile R. R.	1872	Charring.	Piles.	Teredo.	do.	J. W. Putnam.
26	do.	1872	Charring and oiling.	do.	do.	Temporary protection.	Do.
27	Galveston and Houston R. R.	1874	Charring.	do.	do.	do.	Do.
28	Norfolk, Va. ....	.....	Red lead.	Pine and oak.	do.	Failure.	P. C. Asserson.
29	do. ....	.....	Zinc white.	do.	do.	do.	Do.
30	do. ....	.....	Tar and plaster.	do.	do.	do.	Do.
31	do. ....	.....	Kerosene.	do.	do.	do.	Do.
32	do. ....	.....	Rosin and tallow.	do.	do.	do.	Do.
33	do. ....	.....	Fish oil and tallow.	do.	do.	do.	Do.
34	do. ....	.....	Verdigris.	do.	do.	do.	Do.
35	do. ....	.....	Bark on pile.	do.	do.	Good for 5 years.	Do.
36	do. ....	.....	Carboic acid.	do.	do.	Failure.	Do.
37	do. ....	.....	Tar and cement.	do.	do.	do.	Do.
38	do. ....	.....	Davis compound.	do.	do.	do.	Do.
39	do. ....	.....	Carbolized paper.	do.	do.	do.	Do.
40	do. ....	.....	Paint.	do.	do.	do.	Do.
41	do. ....	.....	Thilmany.	do.	do.	do.	Do.
42	do. ....	.....	Vulcanized fiber.	do.	do.	do.	Do.
43	do. ....	.....	Charring.	do.	do.	Good for 9 years.	Do.
44	Balto. & Ohio R. R.	1850	Lime.	Ties.	Railroad track.	Unfavorable	J. L. Randolph.

REFERENCES.

- W. Bowden, Dry Rot, 1810.
P. Mathiu, Naval Timber, 1812.
W. Chapman, Treatise on Preservation of Timber, 1817.
——— Lingard, Timber, 1827.
J. George, Cause of Dry Rot Discovered, 1829.
Dr. Birkbeck, Preservation of Timber by Kyan's Process, 1834.
Dr. Dickson, A Lecture on Dry Rot, 1838.
Tredgold, Carpentry, 1831.
M. Faraday, Prevention of Dry Rot, 1838.
Gmelin's, Handbook of Chemistry.
Spon, Dictionary of Engineering.
Forbes & Hanley, History of British Mollusca.
B. Lottner, Manual of Mining.
Angus Smith, Disinfectants, 1869.
L. Feuchtwanger, Handbook on Silex, New York, 1871.
Roscoe & Schorlemmer, Chemistry.
Knight, Mechanical Dictionary.
Knapp, Chemical Technology.
A. Payen, Précis de Chimie Industrielle, Paris, 1877.
Wagner, Chem. Technology (Crooke's), London.
Watt, Dictionary of Chemistry.
G. Lunge, Distillation of Coal Tar, London, 1887.
E. J. Mills, Destructive Distillation, London, 1886.
Journal Soc. Chem. Industry, London.
Transactions Society of Civil Engineers, London, 1853.
Transactions American Soc. C. E., 1884 and 1886.
Mining and Engineering Journal.
E. H. von Waldegg, Handbuch für specielle Eisenbahn-Technik.
H. Potter, Trans. Soc. Civ. Eng., 1853.
S. B. Boulton, Trans. Soc. Civ. Eng., 1885.

CLASS 64—HYGIENE AND PUBLIC CHARITIES.

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CLASS 64.—HYGIENE AND PUBLIC CHARITIES.

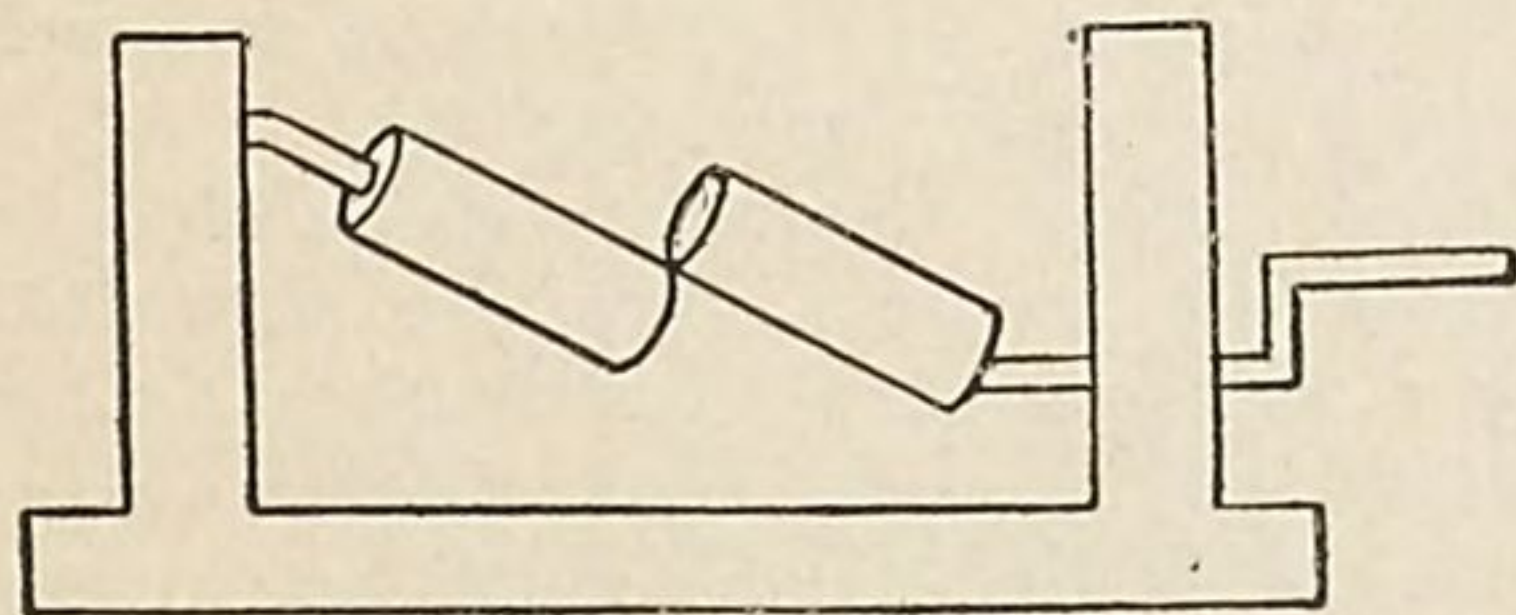
By W. H. CHANDLER, Ph. D.

EXHIBITS OF THE CITY OF PARIS.

These exhibits were contained in two buildings within the park of the Exposition.

Here we find maps showing the extent of the city at different periods of its history. Models of the reservoirs for storage and also of those from which the purest water is distributed for the city supply, together with different forms of conduits used. Models of the different kinds of pavements for the street and of the apparatus used for preparing and laying the same were also shown.

We noticed also an apparatus for testing material to be used for macadamizing roads, designed by M. Couche, engineer-in-chief of the waters of Paris.



Apparatus for testing Macadamizing material. Designed.
by M. Couche.

This consists of two iron cylinders about 2 feet long 6 inches diameter, the bottom of one being attached to the top of the other, touching each other at one point, and the two being revolved by a crank, so as to cause the pieces of stony material placed in them to rub against each other. The durability of the material is determined by the amount of pulverization that ensues.

The laboratory for the testing of material is under the charge of M. Deval.

There were also models and plans of the sewers, and also sections of two houses, one a salubrious house and the other an insalubrious house, as regards their sanitary arrangements.

The municipal observatory at Montsouris exhibited the apparatus used for testing the atmosphere, which is done at noon every day. The ozone is absorbed by a solution of arsenite of potassium, starch paste added and titrated with an iodide of potassium solution of iodine; the carbonic acid by caustic potash solution, and the ammonia by diluted sulphuric acid. A water pump draws the air through the absorption tubes and meters register the amount of air used. The annual publication extends from 1873 to 1888, and is entitled "Annuaire de l'Observatoire Municipal de Montsouris," publisher, Gautier Villars. Le Contre-Amiral Mouchez is the director of the municipal observatory.

Another publication, first issue 1888, is devoted to bacteriology, and has the title "Annales de Micrographie."

The chemical service is in charge of M. Albert Lévy and the micrography is in charge of Dr. P. Miguel.

Other Government publications relating to the city, are "Histoire Général de Paris," 28 volumes; "Annuaire Statistique de la Ville de Paris," 1881-'88.

The municipal laboratory, M. Ch. Girard, director, exhibited the methods and apparatus used therein.

We noticed an air bath lined with porcelain, made by Wiesnegg, Paris. A lacto-butyrometer, made by Alvergnyat, Paris. An extractor, in vacuo, Fortin Hermann, maker. M. Dupré's fractional distillation apparatus, in vacuo, Alvergnyat, maker. Dupré's dialyser and a new burette of constant level.

The department of the Seine also exhibited the plans of the crematory in the eastern cemetery, J. C. Formege, architect, which will be described in our report upon cremation.

In the line of education we find plans and model of the new Sorbonne; plans of school buildings, furniture, apparatus, and books. A portion only of the Sorbonne is completed and during the summer this was opened with appropriate ceremonies.

The department of public assistance exhibited plans of hospitals and the furniture, instruments, and appliances used therein.

Savigny et Cie., Paris, manufacture the instruments used in the city hospitals.

We mention Dr. Nicoletic's operation table, metallic, nickel-plated. From Hôpital Broussais, a surgical washing stand, a light iron stand with four basins; from Hôpital Cochin, a double desiccator; an iron, four-wheel, rolling bedstead, for carrying patients after operations, designed by Dr. Pozzi; steam atomizers, with pressure gauge, for antiseptics, Alfred Aubry, maker, 6 Boulevard St.-Michel; from Hôpital Cochin, an apparatus for weighing a bed with patient thereon and recording the varying weight; from Hôpital St.-Louis, Dr. Lucas's instrument table of iron with tin trays; also Dr. Lucas's Championnière's operation table with two legs and three wheels;

hot box for premature infants; "Couveuse Auvard," H. Galonte & Sons, makers, 2 R de l'École de Medecine; instrument table, of brass, with two glass shelves and rollers, by Dr. Berger; apparatus for heating water, system Piet, which is an upright copper cylinder heated by a gridiron gas-burner; Dr. Pompinel's sterilizing oven for instruments, made by Wiesnegg, Paris; ward table with tiled top; apparatus for purifying atmosphere, system Flicoteaux; from Hôpital St.-Louis, apparatus for analysis of blood, urine, etc., by Dr. Quinquard; rolling ward table for keeping food warm with alcohol lamps, E. Bedouet, maker, Rue St.-Jacques, 340.

Among the publications we noticed Hôpital Cochin, *Comptes Rendus, des Travaux du Laboratoire de Thérapeutique*, Dr. G. Bardet, 1884-'89.

The administration of public assistance exhibited the following publications: "Recueil des Lois, Ordonnances et Decrets applicables à l'Administration Générale de l'Assistance Publique à Paris," 8 vo., pp. 859, Paris, 1887. "Inventaire sommaire des Archives Hospitalières Antérieures à 1790 and supplement," 4 vols., 4to, Paris, 1882-'88. "Collection de Documents pour servir à l'Histoire des Hôpitaux de Paris. Commencie sous les auspices de M. Michel Moring, continués par M. Charles Quentin. Publiés par M. Brieles," 4 vols., 4to, Paris, 1881-'83. "Index Bibliographique des Ouvrages, Mémoires et Publications diverses de MM. les Médecins, Chirurgiens et Accoucheurs des Hôpitaux et Hospices." Exposition Universelle de 1889, 1 vol., 4to, pp. 211, Paris, 1889. "Étude sur les Hôpitaux considérés sous le rapport de leur construction, de la distribution de leurs bâtiments de l'ameublement, de l'hygiène et du service des salles des malades, par Armand Hasson, directeur de l'Administration Générale de l'Assistance publique," 1 vol., 4to, pp. 609, Paris, 1862.

L'ADMINISTRATION GÉNÉRALE DE L'ASSISTANCE PUBLIQUE DE PARIS,
M. E. PEYRON, DIRECTEUR.

From the Government report edited by the director, and from personal observation of many of the institutions, a statement is appended of the various establishments controlled by this department. There are—

	Beds.
13 general hospitals with	6,422
11 special hospitals with.....	4,358
8 asylums and houses of refuge.....	11,793
8 foundations with.....	904
5 foundations lodging... ..	155
Total.....	23,632

The hospitals of Paris are, in general, old-fashioned, but are well conducted and cleanly.

GENERAL HOSPITALS.

Hôtel-Dieu, 1 Place de Parvis, Notre Dame. This is the oldest hospital of Europe, dating back to the seventh century. It was called the Hospital of St. Christopher. It received its present name in the middle of the twelfth century. During the revolution it bore the name of the "Hôpital d'Humanité." Enlarged by successive kings from Louis VII to Louis XVI. Number of beds, 559.

La Pitié, 1 Rue Lacépède. Established in 1612 for the reception of the poor. In 1800 it became an adjunct to the Hôtel-Dieu. Number of beds, 709. A municipal school for nurses is attached to this establishment.

Charité, 47 Rue Jacob. Built in 1637. Number of beds, 516.

Saint Antoine, 184 Rue du Faubourg Saint-Antoine, opened by decree of National Convention, in 1795, in an old monastery. Number of beds, 677.

Necker, 151 Rue de Sèvres. An old convent of the Benedictines was converted into a hospital in 1776. Number of beds, 442.

Cochin, 47 Rue du Faubourg Saint Jacques, completed in 1782, founded by the Abbé Cochin. Number of beds, 386.

Beaujon, 208 Rue du Faubourg Saint Honoré. Founded by Beaujon, receiver-general of taxes in 1784, as an orphanage, converted into a hospital in 1795, with numerous additions to the present day. Four pavilions built 1837-1844. Pavillon Dolbeau, for women's diseases, built in 1877. Number of beds, 432. One pavilion heated by hot water, the others by hot air, which is best. One pavilion has a supply of fresh air forced in by a fan-blower.

Lariboisière, 2 Rue Ambroise Paré. The plan of isolated pavilions, presented by the Academy of Science in 1788, was first inaugurated in this hospital, which was completed in 1854. Comtesse Lariboisière bequeathed nearly 3,000,000 francs to this hospital in 1851. Number of beds 704. Floors are of oak, waxed to a high polish once a week. No water is used, but they are wiped with a dry cloth every morning. The floors of the Paris hospital, as a rule, are in very fine condition. In the new Pavillon Dolbeau, at Hôpital Beaujon, a small building with rooms for women's diseases, are tiled floors, of which the nurses complain in regard to being hard and cold to the feet. A similar complaint reached me from the New York hospital.

At Hôpital Lariboisière a closet heated by steam at 120° C. is used for the disinfection of clothing. All white goods are boiled in closed tanks with steam and soap. Stretchers for carrying the dead are provided with half round covers, made of leather stretched over hoops. A pavilion for contagious diseases consists of seven rooms, not communicating at all, but with a door on either side of room opening to the outer air, heated by grates. The maternity ward has a

rolling carriage to convey the patient from the labor room to the bed in the ward. An eye room, for persons afflicted with diseases of the eye, has windows glazed with blue glass.

Tenon, 2 Rue de la chine, open 1868. Number of beds, 825.

Laennec, 42 Rue de Sèvres. Founded in 1635 with funds given by Madame Le Bret, Jean Joullet, and Cardinal de Larochevoucauld. Number of beds, 628.

Bichat, Boulevard Ney (bastion 39). An old barracks for octroi, converted into a hospital in 1882. Number of beds, 184.

Andral, 35 Rue des Tournelles. Old hospital of Charité-Notre-Dame, suppressed at the time of the revolution, used as a hospital in 1880. Number of beds, 100.

Broussais, Rue Didot. Old domain of Hôtel-Dieu. Used as a hospital 1883. Number of beds, 260. This was built for a temporary hospital for cholera, of which only twenty cases were received. It is built of brick and wood—one thickness of brick, wooden ceilings. It is mounted upon wooden piers and has a double floor. Is cold in winter and warm in summer. Is heated by stoves. Now used as a general hospital. The mortality is said to be one-third less than in hospitals in thicker settled parts of Paris.

SPECIAL HOSPITALS.

St.-Louis, 40 Rue Bichat. Founded by the bureau of the Hôtel-Dieu in 1607. It is devoted to the treatment of skin diseases. Has a service of pay beds. Number of beds, 859.

Midi, 111 Boulevard de Port-Royal. Old convent of Capucine monks. Used as a hospital for venereal diseases of men and women in 1792. For men only after 1836. Number of beds, 336. Has a large collection of plaster casts of cases, which have been treated here. Has a service of pay beds.

Lourcine, 111 Rue de Lourcine. Old house of refuge, converted into a hospital in 1836 for venereal diseases of women. Number of beds, 243. Has an annex with 60 beds for ordinary diseases.

Enfants Malades, 149 Rue de Sèvres. Old home for poor women and girls, founded in 1732. At first an orphanage, but devoted to infant maladies of both sexes from 2 to 15 years of age in 1802. Number of beds, 593.

Trousseau, 89 Rue de Charenton. Founded 1674. Used as a foundling and orphan asylum. Opened as a children's hospital in 1853. Treat all children's diseases, including contagious diseases. Number of beds, 463. We find here three pavilions of wood for contagious diseases—scarlet fever, diphtheria, and measles. A model of these was exhibited at the Exposition. The pavilions are mounted on iron piers; have double floors, with steam pipes between; also double windows, with steam pipes between. The panes of glass are all movable. The ceiling is double. One and a half metres be-

tween ceiling and roof, which latter is covered with zinc roofing. There are grate fires in each ward. Two wards of 24 beds each, which roll upon a track. It is heated by steam. Cost is 72,000 francs for each pavilion.

Clinique d'Accouchement, 89 Rue d'Assas. Opened 1881 by city and state. Number of beds, 130. Formerly near l'École de Médecins. The patient is taken to the lecture-room during the clinic.

Maison d'Accouchement, 123 Boulevard de Port Royal. Ancient abbey of Port Royal. Converted into a hospital in 1795—maternity hospital. Number of beds, 338. Thirty beds in each ward, with two junior nurses for night and two for day service.

THE SCHOOL OF MIDWIFERY.

This is attached to *Maison d'Accouchement*, and is intended to educate midwives of the first class for the whole republic.

The applicants must be between 18 and 35 years of age and of good constitution. They present certificates of birth, of marriage—if married—or, if they are widows, a certificate of death of the husband; a certificate of good life and morals from the mayor of the commune; a certificate of the condition of the mother and father of the student, and, if married, of the husband; a certificate of vaccination or of small pox. Married women must present an authorization of their husbands for their engaging in the occupation of midwife. The students must arrive at the school between the 1st and the 6th of July. The course is not less than one and not more than two years. The school year commences July 1 and ends June 30. During the year the student is allowed to go out six times with their fathers and mothers, or husbands, or some person designated by the administration. No woman enceinte is admitted as a student.

Instruction is given in the theory and practice of accouchement, vaccination, and the care of infants, bleeding and its cessation, elements of botany and pharmacology. The instruction in the school is not gratuitous, the student paying the fees or they are defrayed by their department, their commune, or the hospital administration. The fees are 1,000 francs per year, paid quarterly in advance. Upon entering the student pays—

	Francs.
Fees for the first three months.....	250
Price of books	42
Price of indispensable instruments... ..	11
	303

The examinations and distributions of prizes take place in the months of May and June. There are one hundred pupils in this school. We notice three glass-top boxes, heated by hot-water bottles placed below, for premature babies 6 to 7 months; they are kept in

these from 10 to 15 days. About 10 per cent. of deaths occur in these. In Moscow foundling asylum we recollect the use for this purpose of copper basins, with water jackets heated by alcohol lamps, two babies being placed, side by side, on the bedding therein.

Maison de Santé, 200 Rue du Faubourg Saint-Denis. Founded in 1802, transferred in 1816. Rebuilt 1858. Number of beds, 344. This is intended for pay patients; charges, 5 to 9 francs per day. Mental diseases, epilepsy, and small pox are not admitted. We noticed here a new operation room, with tiled floor and wainscoting 4 feet high of plate glass, bolted to the walls, an excellent material, but in the use of it in a new building there might be danger of fracture by the settling of the building. The writer remembers the use of a similar wainscoting for a large urinal in Jefferson Medical College, Philadelphia, which is much superior to stone of any kind which absorbs more or less material and is not easily kept in a cleanly condition. We noticed also at this Paris hospital the painting of the wall of a ward with a siliceous material, giving a very high gloss, prepared by Vallin, of Paris.

Forges-les-Bains (Seine-et-Oise). Opened 1858 for treatment of scrofulous children annex to Hôpital Enfants-Malades. Number of beds, 224.

La Roche-Guyon, Route de Vernon. (Seine-et-Oise). Donation of Larochefoucauld, 1863. Annex to Hôpital Trousseau. Number of beds, 118.

Berck-sur-Mer (Pas-de-Calais). Founded 1861. For scrofulous children of Paris. Number of beds, 710. Consists of a large hospital of 610 beds, and a smaller hospital of 100 beds for pay patients. The charge is 2.10 francs per day.

The physicians and surgeons constituting the central bureau, and installed in offices in the Hôtel-Dieu, have charge of the examinations of persons who seek admission to the hospitals and of the direction of the establishments which have beds disposable to those cases which demand immediate treatment.

Other persons who present themselves to the central bureau receive gratuitous consultations.

The central bureau also decides as to the incurability of the poor seeking admission into the asylums.

ASYLUMS AND HOUSES OF REFUGE.

Under the name of asylums are included the establishments designed to receive the aged poor or incurables or children without support. They are divided into asylums proper and houses of refuge. Admission into the first is gratuitous; and into the second by means of an annual payment or the deposit of a capital equivalent.

ASYLUMS.

Bicêtre, established in 1656, with many additions to the present time. From 1823 to 1885 it held the name of Hospice de la Vieillesse for men.

Number of beds :

Inmates	2,498
Infirmary.....	166
Insane department.....	840
	3,504

A city school for nurses is attached. For admission of persons 20 years old a certificate must be brought from the physicians or surgeons of the central bureau of admissions that the applicant is afflicted with an incurable infirmity and entirely unable to labor. Preference is given for septuagenarians and octogenarians, the blind, cancerous, and epileptic.

Salpêtrière, 47 Boulevard de l'Hôpital, an old hospital established in 1656. 1823 to 1885 it held the name of Hospice de la Vieillesse, for women.

Number of beds :

Inmates	3,619
Infirmary	272
Insane department.....	720
	4,611

A municipal school for nurses is attached. Here is also the school for the treatment of idiots, conducted by a most interesting lady, Mademoiselle Leontine Nicolle, directrice des écoles, who has devoted herself to this work for many years and who has been decorated by the President of the Republic. The treatment consists in awakening by judicious treatment the dull brains, with occupations similar to those practiced in kindergartens, and, when possible, carrying the instruction forward with reading, writing, arithmetic, etc. In the various rooms the children seemed occupied and happy. Within the precincts of this hospital Dr. Charcot lectures twice a week to two hundred medical students.

Training schools for nurses are at the following hospitals: Notre Dame de Pitié, Salpêtrière, Bicêtre, also Union des Femmes de Paris, 29 Chausse D'Antin.

The length of the course at the hospital is two years; at the "Union" one year, which latter is optional.

Children of employés of the department of public assistance or other public service have the preference. The age is from 18 to 40 years. The lectures are given in the evening upon physiology, anatomy, hygiene, and pharmacy. During the day they assist in nursing, being distributed in the various hospitals. There are two

examinations a year. They receive usually 500 francs per year, sometimes 25 francs per month and their food; they sleep outside the hospitals. Two hundred and seventy-seven diplomas were given in 1888. After receiving their diplomas they serve one year as junior and one year as senior nurse before reaching the position of head nurse. The salaries are respectively 1,500, 1,800, 2,100 francs per year. They take breakfast only in the hospitals, for which they pay 25 francs per month; they sleep outside. After 30 years' service they receive a pension of 600 francs per year.

Their hours are from 6 a. m. to 8 p. m.; every other day, 6 a. m. to 6 p. m. One half day off per week. The night service is given by other nurses.

For two wards, twenty-six beds each, there are two nurses, one dresser, one boy, one bather (woman) two man servants. There are no Sisters of Charity employed as nurses in the public hospitals.

The kitchen is superintended by a high grade nurse, with a junior grade nurse as assistant. In "Charité" hospital, with 546 patients, the kitchen service also included one chief cook, one assistant cook, two boys and one girl.

The laundry is also superintended by a high grade nurse, with a junior as assistant.

There is here a large bath house, with floors, walls, and ceilings tiled, heated by steam, and well ventilated. There are two large rooms, of twenty tubs each, iron enameled; one room for men and one for women. The tubs are separated by partitions 5 feet high, one-half tiled and the upper half of wood. The windows are high from the floor. There are also rooms for douches, plunge bath, vapor bath with steps, steam douche, and a sudatorium, in which the head is not exposed to the heat.

Incurables, Ivry (Seine). Founded 1851. This asylum is devoted to incurables of both sexes.

Number of beds:

Inmates.....	2,040
Infirmery	107
	2,147

Brevannes, (Seine-et-Oise). Founded 1883. Number of beds, 100.

Enfants-Assistés, 72 Rue Denfert-Rochereau. Founded 1795. There are admitted here, from the day of their birth up to the age of twelve, foundlings, abandoned children, and poor orphans. As soon as they are admitted the children are sent to the country; the new-born to wet nurses, and those older to places with artisans or agriculturists. There are also received on deposit children of patients admitted to the hospitals, or those abandoned because of the arrest of their parents, or of those condemned to penal confine-

ment. Finally, the asylum receives the wet nurses of the country, destined for the nursing of the children.

Number of beds :

Children on deposit—

Inmates	378
Cradles	272
Children succored, assisted, or morally abandoned....	146
	796

Thiais (Seine). Established in 1883. This is an annex to the asylum of Enfants-Assistés, for weaned infants on deposit. Number of beds, 100.

Menages, 13 Rue Vivier, Issy (Seine). Founded in 1557; formerly situated in Paris. Originally it received indiscriminately the insane, children, and the infirm aged. In 1801 it was devoted to married couples, in housekeeping, and widows or widowers, over 60 years of age.

Number of beds :

Inmates	255
Infirmery	34
	289

Epileptics, lunatics, idiots, or persons afflicted with cancer, or contagious disease, or disease repulsive in appearance are not admitted. Each inmate pays for dormitory 250 francs per year, or 300 francs for private room, or they deposit a capital of 1,200 or 1,800 francs respectively. They also certify to an annual income of 150 francs for the cost of their clothing and washing of the same. Everything else is supplied.

Larochefoucauld, 15 Avenue d'Orleans. The old domain of the Hôpital Charité, established in 1781, for the treatment of military and ecclesiastical patients. Received its present name in 1822, and converted into an asylum. Admits persons of both sexes, 60 years of age, or those who are impotent as to both limbs or have an incurable infirmity and can not work; the last two cases may be 20 years of age, or over. The annual payment is 250 francs for the healthy aged and 312 francs 50 centimes for the infirm and incurable. The capital deposited in place of the annual payment for the first is from 2,000 francs to 875 francs, decreasing with age when admitted, the first-named amount for those 60 years of age, the last for those 80 years of age. For the infirm incurables the capital is 4,500 francs for those 20 years of age down to 1,050 francs for those 80 years of age. The same restrictions as to diseases which are not admitted as prevail in Asylum Menages.

Number of beds :

Inmates	226
Infirmery	20
	246

Sainte-Perine, 65 Rue la Municipale. Opened 1801. Admits old functionaries and employés of the age of 60 years. They lodge in separate rooms. The annual charge is 1,300 francs, and other expenses are about 500 francs per year.

Number of beds :

Inmates	255
Infirmary	34
	289

FOUNDATIONS.

These establishments have the character of a hospital, asylum, or house of refuge, in conformity to the views of the founders.

Saint-Michel, 10 Avenue du Bel-Air, Saint-Mande (Seine). Founded by M. Boulard; opened in 1830, for the care of septuagenarians.

Number of beds :

Inmates	20
Infirmary	2
	22

La Réconnaissance. Garches (Seine-et-Oise). Founded 1828 by Brézin; opened 1833. Admits certain classes of artisans and workmen, above the age of 60, in absolute indigence.

Number of beds:

Inmates.....	314
Infirmary.....	16
	330

Devillas, 44 Grande-Rue, Issy (Seine). Founded by Devillas, 1832; opened 1835. Number of beds, 65. Receives both sexes of the infirm poor, if 70 years of age. Forty-five beds are nominated by the bureau of benevolence of Paris, and 20 by the two consistories of the Reformed Church.

Chardon-Lagache, 1 Place d'Auteuil. Founded 1863.

Number of beds :

Inmates	150
Infirmary.....	15
	165

Admits persons of both sexes, 60 years of age. Epileptics, paralytics, lunatics, idiots, and persons affected with cancer, and certain contagious diseases are not admitted.

Lenoir-Jusseran, 10 Avenue du Bel-Air, Saint-Mande (Seine). Founded by Mme. Lenoir-Jusseran, 1876. Receives the aged of both sexes of Paris.

Number of beds :

Inmates	132
Infirmary	10
	142

Pavillon Moiana, 184 Faubourg Saint-Antoine. Bequest of M. Moiana, 1876. Annex to Hôpital Saint-Antoine. Number of beds, 20.

Orphanage Riboutte-Vitallis, Forges-les-Bains (Seine-et-Oise). Bequest of M. Vitallis. Opened in 1882. Number of beds, 40.

Foundation Rossini, 16 Rue Mirabeau. Bequest of Mme. Rossini, 1878. In construction.

Foundation Galignani, Neuilly (Seine). Land from bequest of M. Galignani, 1882. In construction.

Debrousse, 148 Rue de Bagnolet. Bequest of Mme. la Varonne Alquier, née Debrousse, 1883. In construction.

Lambrechts, Rue de Colombes, Courbevoie (Seine.) Founded by Michel Moreau and Bauneau heirs, 1843-1876. Administcred by a board of directors. There are admitted the blind poor over 30 years of age, indigent aged of 70 years, infirm men of 50 years, infirm women of 55 years and poor children, entire orphans, from 7 to 13 years of age. The admissions are made by two Christian commissions of the Augsburg Confession and Reformed, of the department of the Seine.

Number of beds:

For aged	40
For children.....	70
	110

ESTABLISHMENTS OF GENERAL SERVICE.

Approvisionnement Central, at the Halles. Established in 1853. For the purchase of fish, poultry, fruits, vegetables, etc., of the season.

Boucherie centrale, 151 Boulevard de l'Hôpital.—Established in 1848. The animals are presented on foot for the examination of an expert; after slaughtering they are subject to another valuation; they are cut up under the surveillance of the director and distributed among the various establishments, in accordance with the demands.

Boulangerie Centrale, 13 Place Scipion.—Established in 1797. The bread is here made for consumption in the various establishments.

Cave Centrale, at the general depot of wines, Rue des Fosses-Saint-Bernard. All the wines are distributed from this place.

Magasin Central, 89 Boulevard de l'Hôpital. Established 1866. This supplies and makes up the linen, clothing, and bedding; also provides the furniture and utensils and purchases the raw material and foreign commodities, for the service of special supply.

Pharmacie Centrale, 47 Quai de la Tournelle. Established 1812. This supplies the medicines and pharmaceutical substances for the hospitals, asylums, and bureaux de bienfaisance.

Amphitheatre d'Anatomie, 17 Rue du Fer-a-Moulin.—For the instruction of students in medicine and surgery. A number of the

corpses of those who die in the hospitals, and which are not claimed by their families, are carried here each day.

Bureaux de Bienfaisance.—These are twenty in number and distribute aid and treatment for the sick at the houses. In each arrondissement of Paris is a central house and a house of assistance, where gratuitous consultations are given.

The following establishments are under the control of this bureau :

Hospice Leprince, 135 Rue Saint-Dominique. Donation of M. and Mme. Leprince, 1809. Receives aged poor of both sexes of the Quartier des Invalides. Number of beds, 23.

Foundation Lesecq, 3 Rue Belzunce. Bequest of Mme. Lesecq, 1675. For gratuitous lodgings for women under 50 years. The twenty bureaux select the occupants of the rooms. Number of beds, 20.

Foundation Tisserand, 134 Rue d'Alesia. Founded 1877. Gratuitous lodgings for old men, living in the quarters of Petit-Montrouge and Montparnasse ; 30 pensioners also receive one franc each per day. Number of beds, 48.

Foundation Damet, 19 Rue Lemercier. Bequest of widow Damet, 1864, twenty-four lodgings for the aged, eight for couples, and sixteen for single persons.

Hospice de Belleville, 180 Rue Pelleport. Founded by the old commune of Belleville ; after the commune was annexed to the city in 1860, the asylum was administered by the department of l'assistance publique. Number of beds, 40 ; for the use of aged poor of both sexes living within the commune of Belleville.

Service des Enfants-Assistés et des Enfant Moralement Abandonnés.—Agencies throughout France. Also has direction of the following :

École de Reforme, d'Yzeure (Allier). Old Benedictine convent. Opened for this purpose 1885, for girls, assisted or abandoned children.

Professional Schools, school of Horticulture, Villepreux (Seine-et-Oise). Founded 1882.

School of Cabinet-making, d'Alembert, at Montevrain (Seine-et-Marne). Founded, 1882.

École d'Alençon (Orne), 1885. Printing, carpentry, saddlery, locksmith's work.

St.-Joseph Hospital, a private corporation, under charge of Sisters of Charity. Consists of four two-storied pavilions, 35 by 30 feet, with a building between the four, for offices, etc., to which they are connected in the basement by closed passages surmounted by open piazzas. On the first floors are the wards, eight beds each, and on the second floors are private rooms. This is near Hôpital Broussais, and is mentioned here as a new plan of construction.

SOME MODERN PAVILION HOSPITALS.

As typical pavilion hospitals of the first class are here given the plans and descriptions of the following institutions :

(1) The City Hospital, Antwerp, Belgium. This consists of circular partitions of two stories connected by closed corridors.

(2) The Berlin City Hospital. This consists of rectangular pavilions, entirely isolated, with two stories for medical and one story for surgical pavilions.

(3) The Johns Hopkins Hospital, Baltimore, Maryland, one-story pavilions, connected by closed corridors, on basement floor only ; one octagonal and the others rectangular.

(4) St. Luke's Hospital, South Bethlehem, Pennsylvania, one-story rectangular pavilions, connected by covered corridors, open at the sides.

Although the modern use of antiseptics may render any form of hospital aseptic, yet the pavilion design offers many advantages, when the space is available, giving a free access of air and sunlight. In outbreaks of contagious diseases, so liable to occur with children especially, these can be so much more easily handled in isolated pavilions than in block hospitals.

When it is possible hospitals should have their long sides placed in a north and south direction, so that the rays of the sun can reach both walls of the wards.

THE CITY HOSPITAL OF ANTWERP, BELGIUM.

[Translation of a brochure by the Director, with 2 plates.]

It had been recognized for a long time that the vast St. Elizabeth Hospital no longer answered the needs and the growth of the population of Antwerp, nor the requirements of modern science. In 1872 the administration of civil hospitals submitted the plan of a new hospital with separate pavilions, on some ground outside the city, 38,500 square metres in extent, near the fortifications (220 metres long by 175 metres mean width). The plan adopted was that of the Architect Baehelmaus. Messrs. Bilmeger and Van Biel, his pupils, were intrusted with the execution of this plan, after certain modifications suggested by the superior council of hygiene had been made.

The ground occupied by the buildings is 10,813 square metres in extent. The establishment is connected with the town by a line of tramways. It is completely surrounded by walls, which are surmounted by grating of wrought iron.

GENERAL ARRANGEMENT.

The principal entrance is in the center of the block of buildings forming a monumental façade, fronting upon the Rue des Images. This contains, on the ground floor, immediately to the right, the lodge and the dwelling of the porter, and at the end the dwelling of the chaplain. On the left, the offices of the administration; and farther on, the director's house, thus forming the counterpart of the chaplain's, both having gardens. Beyond, on each side of the principal entrance, is the approach to the halls which lead to the pavilions, and also to the other outbuildings, with which they are connected by secondary halls.

At the end of the same principal entrance, to the right, is the consulting room of the physicians; and on the left, the room for the nurses.

In the same block of buildings are situated the waiting and reception rooms, a room for keeping personal effects and clothing, and also a bathroom for the sick upon their entrance into the hospital.

On the first floor are the rooms for the meetings of the administrative council, the lodging rooms of the boarding students, and on the second floor the dormitories of attendants and servants, who alone occupy eight large rooms.

The main entrance, after crossing the building which has just been described, opens into the first court, called the court of the chapel, by a paved carriageway, which leads round this building to the second court, which gives access to the kitchen and its dependencies.

The first court, with an area of 1,600 square metres, is embellished

with beds planted with shrubs and flowers. These beds are cut in the lawn, which is outside the paving.

The chapel is 25 metres long by 18 wide.

The principal galleries form a large rectangle, 160 metres by 70, with the angles cut off, with an inclosed area of 400 metres.

As we have already seen, they open upon the principal entrance. From thence they serve the operating room and the morgue, with which they are connected by a passage 10 metres wide ; they then give access to the chapel, by two covered galleries, on columns, one on the left, the other on the right of that edifice. Then they communicate with each pavilion, and are connected by passages which cross the pharmacy and the kitchen as well as the cloister. They are surmounted by vaulted platforms, asphalted, with cut stone, upon which are fixed railings of wrought iron. These platforms are used as walks by the convalescents, and serve as means of communication between the stories of the pavilions.

These same galleries are lighted and aired by large doors 2 metres wide, at intervals of 3.40 metres.

The slight elevation of these galleries allows the air to circulate widely in the four courts and gardens established between each group of buildings.

On the right of the front, a little farther from the street, is the morgue. It comprises a dead room with twelve slabs of blue stone, constantly wet with carbolated water ; a room for exposing, and another for autopsies. The dressing of the dead is done in a cellar, whither the corpses are taken directly from the rooms by subterranean galleries, which lead on one side to the central elevators and on another to that of the morgue.

Opposite the morgue, and separated by a court, is a building that faces the street ; it serves as a workshop, with a stable and lodging for the coachman.

On the left of the principal front, a little back from the street, are two operating rooms, with a special entrance on the Rue de Lazaret ; waiting rooms for patients to be operated upon, and resting rooms for those who have undergone operations ; finally, several rooms for the use of the physicians and their assistants, closets for the numerous surgical instruments, and a room for the treatment of the diseases of the eye.

In establishing the hospital the administration had especially in view epidemic diseases. It can shelter five hundred patients. The eight two-storied circular pavilions are placed 23 metres apart, and afford sixteen sick rooms, all shaped and arranged alike. This circular form offers the double advantage of being less favorable for the accumulation of dust, of the products of desquamation, and of making the change of air more regular. It facilitates also the superintendence of the room. Each room contains twenty-six beds, besides

three rooms of isolation. The last two rooms on each side are reserved for paying patients.

A stairway, with a landing half-way up, all of first quality oak, 1.60 metres wide, leads to the first floor of each pavilion.

Near this stairway is a closet for stowing things used in cleaning the rooms. Two conduits lead from it, one for the sweepings, the other for the soiled linen which is to be taken to the laundry through the large subterranean passage which connects all the parts of the whole establishment.

The principal galleries communicate with the pavilions through a passage 9 metres long. On each side of the beginning of this passage is a room for isolation.

Each large sick room is 20 metres in diameter. The twenty-six beds that it contains are 1.45 metres apart at the head and 0.90 metres at the foot. The cubical content is 1,395.96 cubic metres, so that, deducting the glazed cabinet of the hospital sister, each patient has 53.69 cubic metres of air. Light is admitted through twenty high windows, fitted in the upper part with swinging casements. The sills are of marble and slope so much as to prevent putting anything on them. The walls are covered with stucco. The floors are of polished oak. In the center of the pavilion is a large column of sheet iron, carrying off through the cellars the bad air. The air, heated by contact with steam coils which are in the basement, is distributed in the rooms by eight hollow columns of cast-iron which support the iron superstructure of the arches.

From her lodge, the sister superintendent directs the heating and airing of the room by means of movable cranks and valves, placed at a convenient height. This glazed lodge, of octagonal shape, surrounds the ventilating chimney; its perimeter is bound by the eight cast-iron columns mentioned above, and the floor is 18 centimetres above that of the room; it is 2 metres high. It is provided with numerous shelves for the medicines, dressings, etc.

A passage, which is the prolongation of the principal entrance of the pavilion at the other end of the room, leads to an extension which comprises on the right the room where plasters or poultices are also prepared by means of a gas stove; on the left, a bath room fed by hot water, which is obtained of any desired temperature by taking cold water and steam. In the back part of this passage, a wash-stand of polished granite, with revolving basins; on the left of this a urinal and a sink for washing utensils; finally, on the right, nine water-closets with double bowls, the gases of which are carried off by a pipe communicating with a ventilating special chimney.

The same arrangements are adopted on the floor above.

In six buildings for servants' quarters, on the ground floor, is a special room destined to receive provisionally the dead, in order to

withdraw them from the sight of the convalescents, before carrying them to the morgue by the elevator.

There are thirty-two rooms for pay-patients, with presses, arm-chairs, tables, and water-closets.

There is also a common room, used as a smoking room and day parlor, in the part, reserved for men, and a similar department, as a sewing room, in the women's quarter.

There are also two cushioned rooms for violent patients. The arrangements are identical in all the pavilions, both for men and for women.

The total number of wards and rooms heated and ventilated for the use of patients is one hundred and two, the total capacity of which is 32,500 cubic metres.

In the center of the edifice, in the second court, with an area of 1,700 metres, are the places set apart for the domestic management. There are, first, two refectories, one for the men the other for women, with a view of the gardens. The furniture of these, like that of the play room, is of pitch pine, varnished, or red pine, a beautiful wood, of superior quality of North American growth. In the front part is the kitchen, with its dependencies; the wash room for the dishes, a storeroom, and large cellars. The kitchen contains three large coppers of a capacity of 225 litres each, three of 150 litres each, an apparatus for cooking 125 kilogrammes of potatoes, and two apparatus for heating milk; two large closets, intersected by steam coils covered with polished sheet iron, are used as plate-warmers; a coffee-boiler, containing 120 litres. All these apparatus are heated with steam. The roasting stove alone has an uncovered fire. Quite near by are the refectories of the house surgeons, the attendants, and the servants.

Opposite, in the back part of the same building, opening upon the third court or garden, with an area of 1,500 metres, is the pharmacy and its offices, stores, laboratory, wash house, etc. The laboratory, which furnishes medicines to the St. Elizabeth Hospital, the secondary establishments, orphanages, asylum for the old, and the lunatic asylum, answer all requirements of science and technical instruction. The power used for the apparatus is gas and steam. Large storerooms and well-aired cellars complete the arrangements for this department. Between the kitchen and pharmacy building and the cloister building a large piece of ground has been reserved for the botanical garden.

The sisters placed in charge of the service of the hospital are lodged in the cloister between the third pair of pavilions, and are twenty-eight in number. They have, besides their cells, several parlors, a dining room, a workroom, a library, and an oratory. On the first floor are situated the linen closets and the storerooms for materials used in dressing wounds, etc. The space between the

cloister and the end of the gallery, an area of 1,000 metres, is laid out as a pleasure garden for the use of the community; the center is occupied by a large lawn.

At the end of the large gallery of communication is the bath-house, containing twelve rooms for the use of patients. In the middle of the building are five bathing rooms and other arrangements—sulphur baths, Russian baths, Turkish baths, shower baths, with resting rooms, etc., which are also for the use of the public.

Behind the baths, from which they are separated by a large grass plot, which serves as a drying ground, occupying the whole front on the Rue Van Boerhaeve with a width of 25 metres, are the buildings for the machinery and the central laundry. The central laundry is very large; for it has to suffice for the needs of the interior as well as for those of all the hospital establishments—the St. Elizabeth Hospital, the Ophthalmic Institute, the Orphanages, the Lunatic Asylum, the Home for Old People, etc. The whole system is operated by superheated steam. There is washed here daily from 1,000 to 1,200 kilogrammes of linen by means of four washtubs of a capacity of 500, 400, 300, and 250 kilogrammes, respectively. The steam drier contains twelve drawers, with an ordinary temperature of 55°C . The disinfecting stove has a mean pressure of $5\frac{1}{2}$ atmospheres, which can easily be raised to 180° . The next story is occupied by the rooms where the washed articles are ironed, classified, folded, and prepared. It is reached by an elevator. The garret is a large drying place with free circulation of air.

This part of the building is provided with two *portes-cochères* opening on the Rue Van Boerhaeve. One can drive around it on a paved way.

The six groups of buildings—administration, chapel, kitchen and pharmacy, cloister, baths, and steam laundry—have a common axis separated on each side from the two rows of pavilions by a distance of 55 metres.

The engine which drives the whole apparatus is of 15 horse-power, but only two-thirds of this power is used. All these machines, engine included, are from the shops of MM. Pierron & F. Dehaitre, Paris.

The courtyards are the excess of the total area of the hospital, deducting the buildings, courts, and gardens; that is, 3.86 hectares, less 1.66 hectares=2.20 hectares; about 1.20 hectares each. The one for the men is on the left, the one for the women on the right. They are intersected by numerous winding paths, from 3 to 4 metres wide, covered with cinders. The grass-plots are elliptical, and are bordered with trees planted near together. There are clumps of trees at the angles.

Along the walls of the inclosure there are four cesspools, two on each side, for the evacuations coming from the wards. There have

been placed over the cesspools water-closets for convalescents when they are working in the courtyards, and a room for keeping the garden tools. On the streets are placed urinals for the public, and a special entrance for emptying the cesspools.

HEATING AND VENTILATING.

Three tubular boilers, of 80 horse-power each, pattern of De Nayer & Co., of Willebroech, perform this duty. They furnish steam for the motor, for ventilation and heating, for the requirements of the laundry, and the laboratory of the pharmacy. A conduit collects the condensed water and takes it back to a large cistern near the boilers, which they reach at a temperature of 70° to 80° , to be used again for feeding the boilers by means of two direct-acting pumps. The pressure in the conduits is from 4 to 5 atmospheres; at the outlets of the conduits leading toward the parts to be heated (wards, etc.), are automatic valves with steam gauges which reduce the above mentioned pressure to $1\frac{1}{2}$ atmospheres (less than 110° C.) in the bifurcated parts.

The steam pipes are placed under the floors of the subterranean galleries, in a trench of masonry covered with movable slabs of cast-iron. The subterranean galleries support the galleries of the ground floor.

The whole block of buildings is vaulted and afford spacious cellars, well aired, cemented, and provided with cisterns.

The ventilation for all the sick wards is done in two ways: naturally, and mechanically. Fresh air from outside is admitted liberally through casements into the sick wards, and constitutes the natural ventilation.

For mechanical ventilation, a large subterranean canal, vaulted, 1.20 metres in width and 1.70 metres in height, making the circuit of the hospital, with branches to each pavilion, affords a passage to the air which two mechanical ventilators, with a speed of 780 revolutions a minute, forces into the ten wards of the infirmary, after having drawn it from the outside through two turrets placed near the laundry.

The ventilation is for winter and summer. In summer the foul air is drawn through eighteen registers placed near the ceiling; in winter through twenty-eight registers on the level of the floor. These forty-six registers are openings of pipes, which, under the floor and above the arch of the ceiling converge toward a central chimney with double walls. There the foul air is drawn downward through the outer space by a permanent fire in the center, is burned by contact with a coil filled with steam, and then, purified, escapes outside through the central part of the chimney.

For the servants' quarters, for the wards intended for paying patients, for the operating rooms, the refectories, and certain rooms

of the kitchen department, of the pharmacy, and of the laundry, the outlet of foul air is effected by means of vertical conduits placed in the thicknesses of the walls, joining at the top, at the foot of an exhausting chimney having an heated draft. The building occupied by the baths is ventilated naturally ; the foul air escapes by openings fitted with swinging shutters.

The autopsy room and the morgue are ventilated by downward conduits in the thicknesses of the walls. The foul air escapes under the floor of the cellars into a wide passage ending in a special draft room arranged under the chimney and containing five powerful high-pressure steam coils. This powerful apparatus renews the air six times an hour.

The administration building, the chapel, and the cloister of the Sisters are not included in the general system of ventilating and heating.

This system of ventilation and heating was furnished and set up by Messrs. Sulzer Brothers, of Winterthur, Switzerland.

DISINFECTION.

The disinfecting stove is placed in a special compartment, near the laundry ; this compartment has an outlet near the portes-cochères into the Rue Van Boerhæve.

The masonry is 2.45 by 2.12 metres, with a height of 2.27 metres. It is provided with a folding-door of iron 1.98 by 2.12 metres.

The work is done by means of two vehicles ; a cart, which can carry three mattresses, six counterpanes, six sheets, bolsters, and pillows ; and a car circulating in the upper part on rails. This latter is used for articles of dress, linen, etc. The clothes of ten persons can be hung on it one by one.

The use of these vehicles does not necessitate the presence of the workman in the stoveroom ; the loading and unloading is done outside.

In the lower part is placed a pipe of wet steam, with its distributing cock.

A pressure of 80 horse-power can be obtained, say, 4 to 5 atmospheres, and even $5\frac{1}{2}$, without forcing. Ordinarily only 40 horse-power is used in order to get, in 10 minutes $+ 120^{\circ}$ by the outside thermometer, and 140° by the interior, wet steam ; 130° outside is equivalent to 150° inside, dry steam. With 5 atmospheres one would reach more degrees, but they would be of little use ; 130° outside suffice for all the needs of disinfection.

The clothes of people entering the hospital are subjected for 30 or 40 minutes to the wet steam (110° to 120°). They are at first charged with condensed steam, which covers them with a coating of moisture ; by closing the escape register and that of the vaporizer,

the superfluous steam is directed into the heating pipes so as to raise the temperature gradually.

The moisture upon the clothing is vaporized; the steam penetrates all the fibers, and the heat is sufficiently distributed to complete the destruction of the germs.

The clothing of small-pox, typhoid, and other cases of a similar character, as well as the hand ambulances used for carrying the patients, are disinfected separately; carriages which bring to the hospital patients affected with contagious diseases are disinfected in the great entrance court.

The position of the disinfecting apparatus being isolated with a special entrance, affords an entrance to it without passing through the hospital. Clothing for disinfection is also received from the outside.

The total cost of this apparatus, including the cart and the car, was 5,395 francs set up. The apparatus was also furnished by Messrs. Pierron & F. Dehaitre, of Paris.

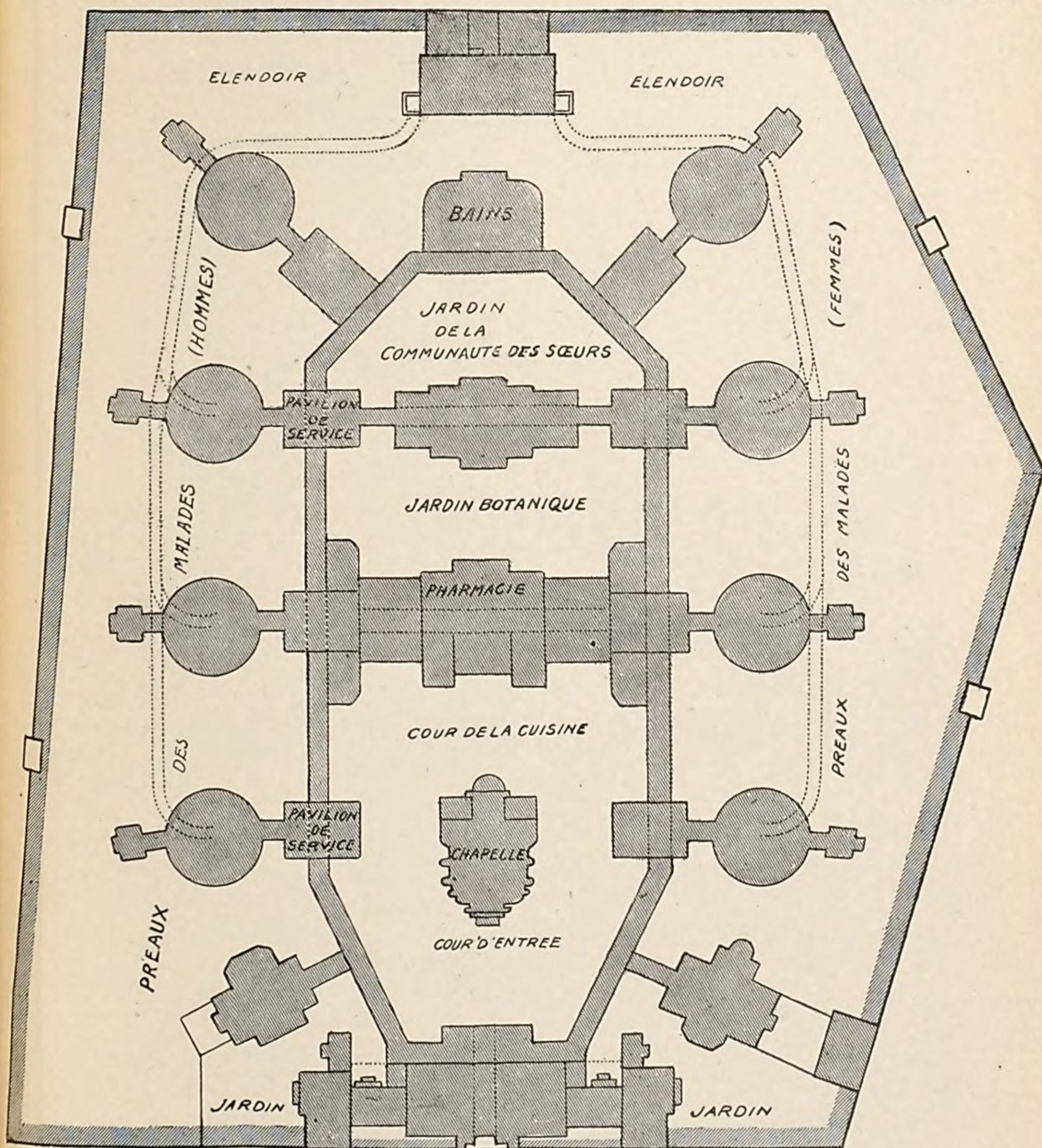
The medical staff is composed of three surgeons and three physicians; one chief apothecary, five assistants in medicine and in surgery, three in pharmacy.

The cost of maintenance is 2.50 francs for the common wards; it is 5 francs for the reserved rooms.

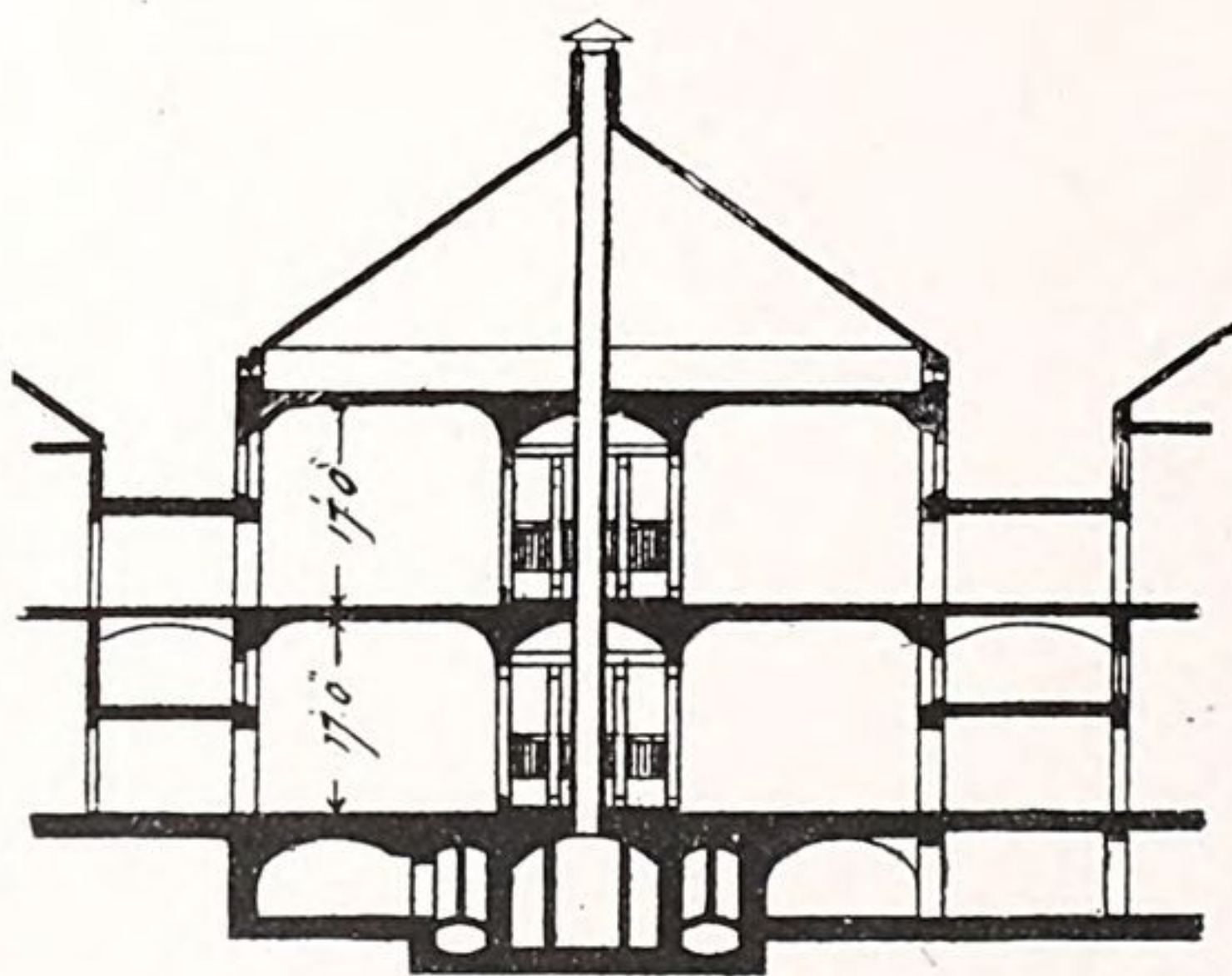
The carriages used for transporting the sick and the wounded are remarkable for comfort and safety. Their cost is 450 francs; they were supplied by the "Company for the Construction of Carriages" (firm of Jos. Neuss, Rue Frédéric, 225, Berlin).

The total cost of the fine establishment was only 3,209,387 francs. It compares favorably with the best equipped modern hospitals; among others, the Friederichsheim, of Berlin; that of Bourges, Vincennes, and Montpellier, in France. It is peculiar in being at the service of other establishments of public assistance, and even of the public, for baths and the disinfection of bedding. In a word, on account of its arrangements and its accommodations as regards comfort and hygiene, it is the admiration of many strangers and experts who have visited it.

ANTWERP, *August 25, 1888.*

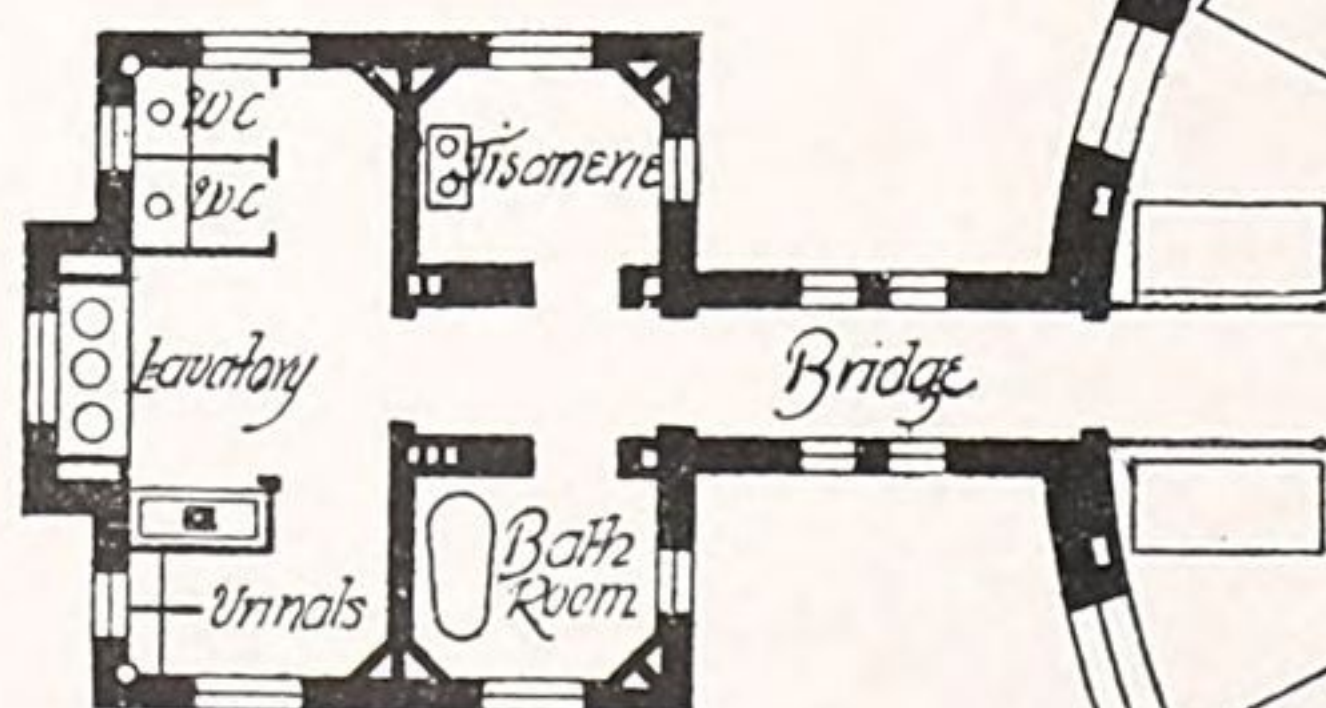


CITY HOSPITAL, ANTWERP, BELGIUM—GENERAL PLAN.

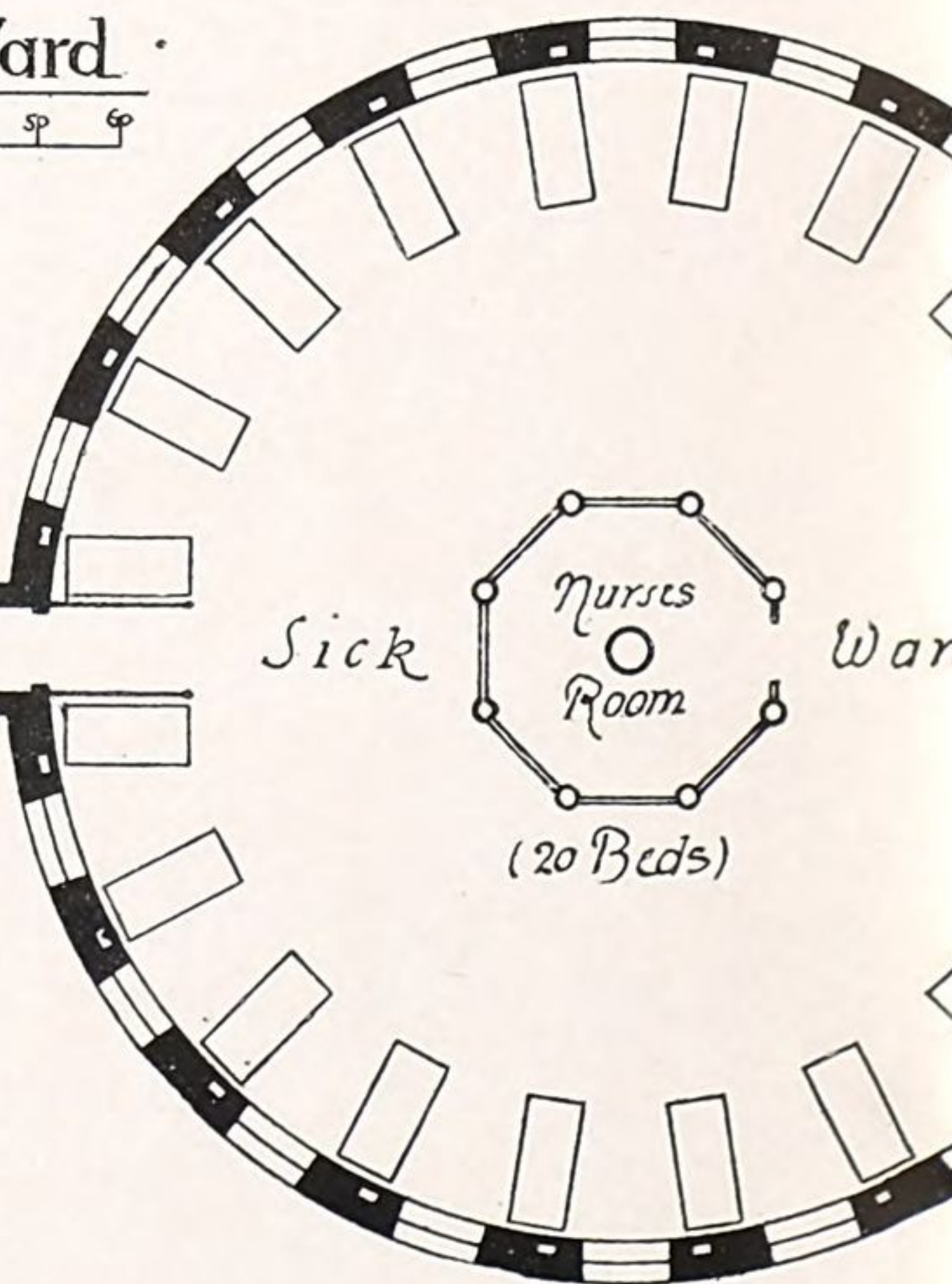


Section thro' Ward.
Scale of Feet
10 15 20 25 30 35 40 45 50 55 60

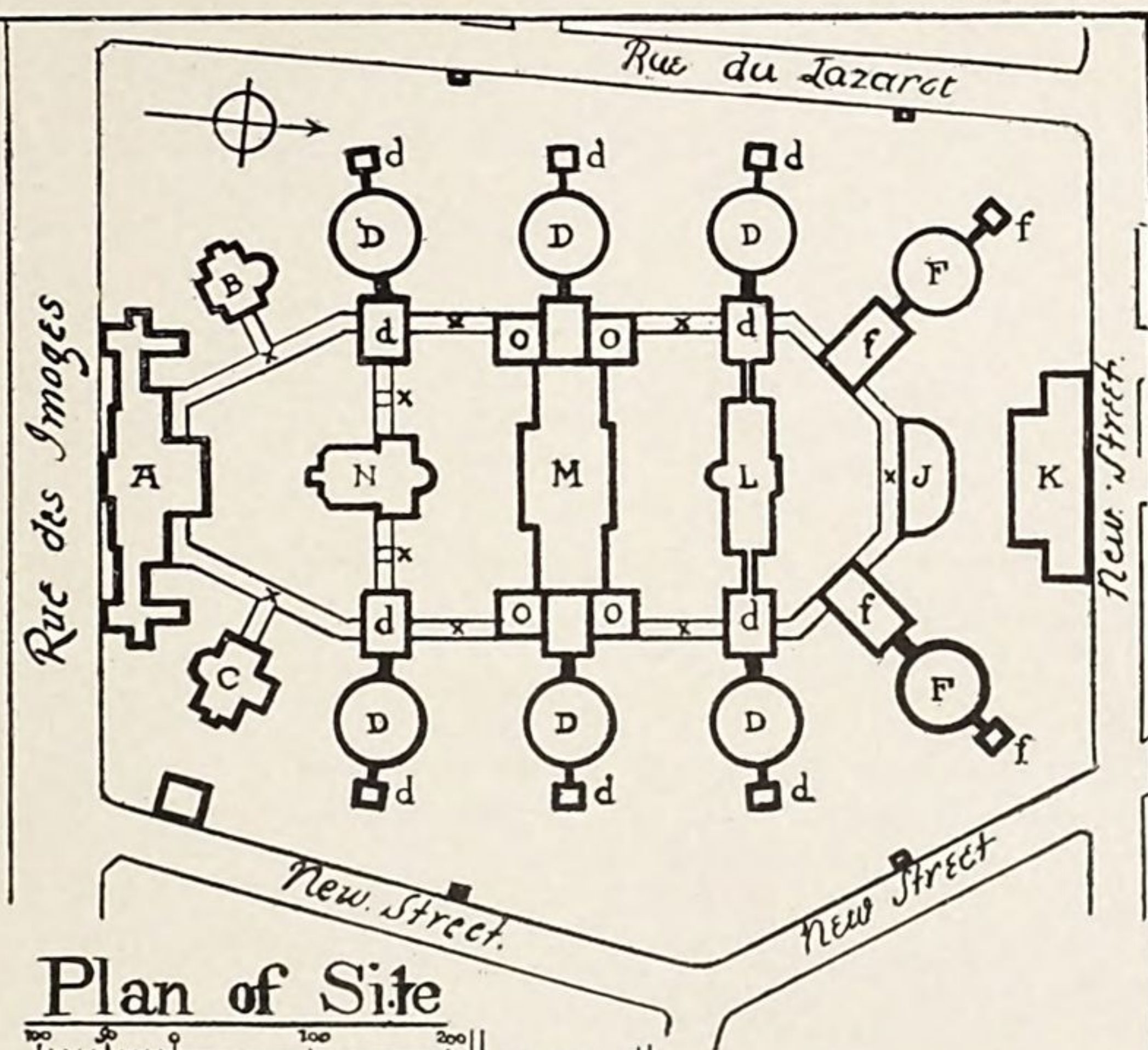
A. Entrance-Offices
Residences-
B. Operation Room.
C. Mortuary-
D. Sick Wards
d. Ward Offices.
J. Baths.
K. Laundry
L. Nurses.
M. Kitchen- Dormitory
N. Chapel.
O. Patients Dining
xx Covered Ways



a. Shoot for rags & poultices.
b. Do for dirty linen.
c. Pipes.
d. Sink.

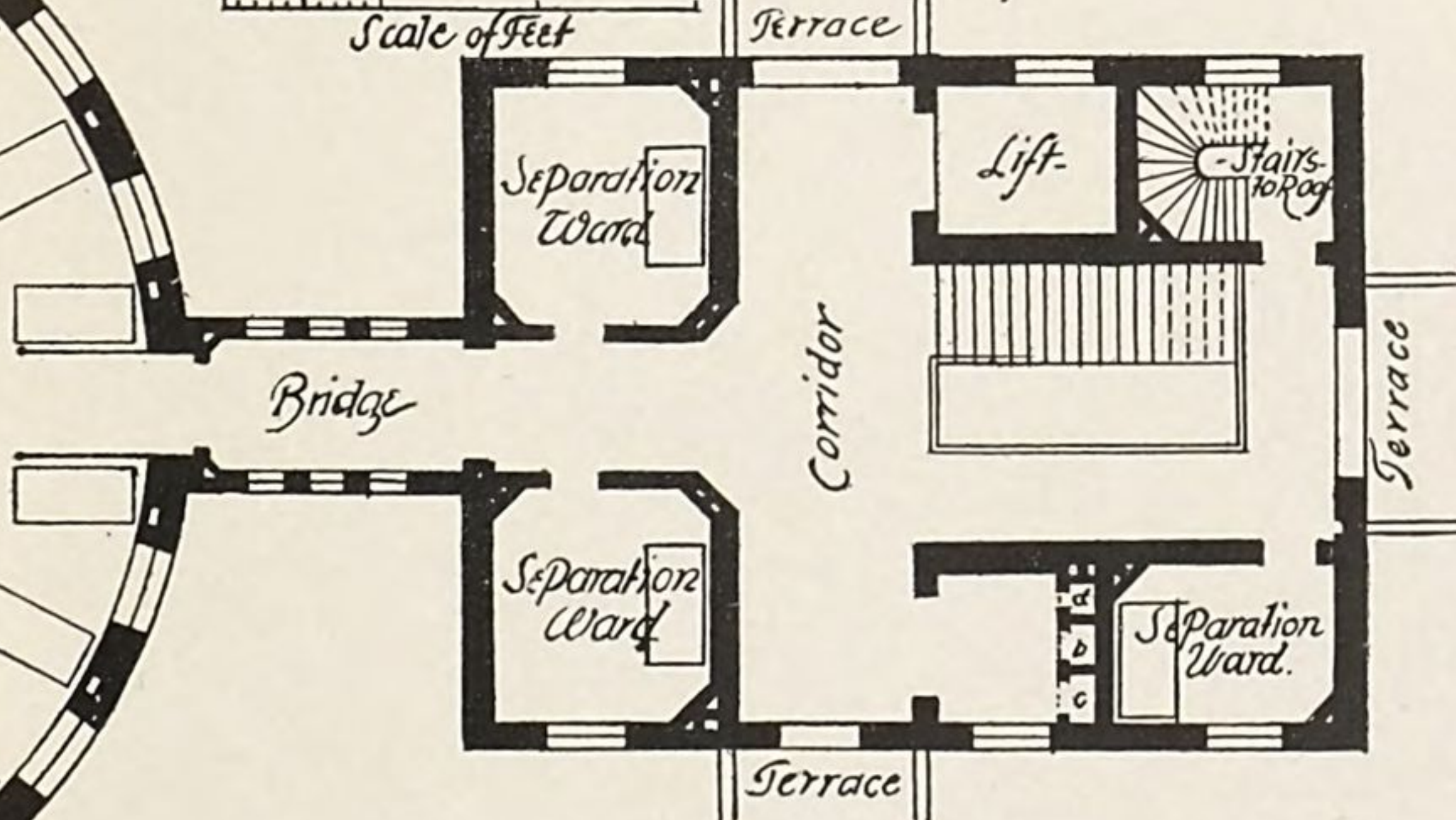


Nurses
Room
(20 Beds)



Plan of Site

Scale of Feet



Plan of Pavilion First Floor

Scale of Feet

THE GENERAL CITY HOSPITAL OF BERLIN, GERMANY.

[Condensed from a brochure by V. Von Weltzien, with 9 plates.]

A legacy of 50,000 thalers in 1866 was the moving impulse for the erection of this hospital, certainly one of the best constructed institutions of the kind in the world.

The Architects Gropius and Schmeiden formulated the original plans, which were examined and revised by a committee appointed by the city council, composed of City Councilman Noeldechen, City Building Committeeman Meyer, and Professor Dr. Virchow, Dr. Neumann, Halske, and Voigt, from the two city colleges. The following were appointed as a consulting committee: Dr. Esmarch, of Kiel; Professor Baum, of Gottingen; Professor Von Langenbeck, Dr. Wilms, Dr. Quincke, and managing officers, Dr. Esse and Director Herfordt, all of Berlin. The land occupied for the hospital is 95,500 square metres in extent. The buildings were erected during the years 1868 to 1875.

	Marks.
The total cost of the buildings and furniture was...	4,520,789
Deducting furnishing, etc	303,528
Buildings.....	4,217,261

The total number of beds is 600, making the cost per bed 7,028 marks.

THE ADMINISTRATION BUILDING.

According to the first sketches, the administration officers, etc., now in one building, were to be divided among three buildings; two small houses affording dwelling places for the medical directors, and a third containing only the officers of the administration, the receiving rooms, the pharmacy, and a bedroom. But it was afterward decided to collect all these in a single building, with the exception of the bedroom, this building to contain the principal entrance to the establishment.

The lofty entrance hall is provided with a glazed iron partition, in the middle of which is a double door, and on each side a single door. Only in cases of severe illness is the carriage conveying the patient allowed in this passage; from here he is taken in a small covered conveyance to the pavilion where he is to be treated.

To the north, on the ground floor, next the entrance, is the porter's room. Next, opening into a wide hall, are the rooms for the people seeking assistance; namely, two waiting rooms, having between them the room of the physician on duty. Farther on are the directors' offices and the general offices of the administration. Here also are the closets and the apartments of an assistant physician, two

rooms. The hall leading to the receiving rooms, which is used as a waiting room, is heated and provided with seats.

Toward the south, next the entrance, approached by a similar hall, is the pharmacy. A small flight of stairs connects this with a kitchen in the cellar. There are also on this side the apartments of the dispenser and the apothecary, as well as the assembly and reading rooms for the assistant physicians. Finally, there is an apartment of five rooms, with cellar, etc., below, for a chaplain or a married dispenser.

The basement contains, besides the places already mentioned, storerooms, two bathrooms, and four sets of apartments for subordinate employés. The remaining space is devoted to the heating apparatus and coal.

According to the original plans, the upper stories of the wings were to contain on one side the apartments of the medical director and those of the chief physician, and on the other side four small apartments for the chief inspector, housekeeper, a steward, and a secretary.

This arrangement was changed, owing to the administration being placed in the hands of two physicians and a director instead of being confided to one person. Shortly before the opening of the institution, apartments were arranged in the south wing for the two medical directors, and in the north wing apartments for the administration director, and on the second story apartments for the housekeeper, and a few rooms for an assistant physician.

ECONOMY BUILDING.

The original intention was to divide the housekeeping among several buildings. This plan had been decided upon because, according to the experience of the architects, larger buildings adapted to several different purposes are more expensive than a number of smaller buildings. Nevertheless, it was determined to unite under one roof the kitchen and the laundry. The building was divided into two equal parts; in the southern part is the kitchen, in the northern part the laundry. Each of these has its dependencies.

The middle portion of the building is 14.80 metres deep, 42.30 metres long, with wings 20.30 metres deep and 11.60 metres wide. The chimney, in the middle of the building, rises 14.25 metres above the roof. The floor of the shed for boilers and engine is on the same level as the cellar. This shed contains, besides, a small workshop, the coal bunkers, and the steam disinfector for the clothing of the patients. There is also a water-closet for the attendants of the economic establishment. This is accessible from the economic building.

The vaulted cellar, which extends under the whole of the main building, is reached by means of three inside and one outside steps.

The boiler room is also accessible from without, as well as from the laundry. The cellar, for the storage of meat, wine, etc., is divided into rooms by lath and plaster partitions. Finally, there is in each wing a heating apparatus, Heckman & Zehender system, for heating living and store rooms, whilst a third apparatus, placed near the chimney, heats a winter drying room.

The entrances to the ground floor are so arranged that on the west side, near the middle, the doors lead to the kitchen and laundry; those on one side are for giving out food, those on the other for the delivery of soiled linen. On the north and south, doors and corridors communicate with the neighboring rooms, and also with the laundry and kitchen respectively. There are also two approaches under the granite stairs, which lead on each side to the top story. Besides these two staircases there is a third in the main building, which leads to the top story.

The laundry and the kitchen occupy the whole depth of the building, and are 13.30 metres long, 9.40 metres wide, 8.20 metres (two stories) high. They are vaulted, with iron beams and no pillars. Iron galleries give access to the upper windows. The floors are of ribbed flagstones, set with a slope, so that all water is led off by means of drains. Walls and ceilings are painted. The window frames are of wrought iron; the upper half is easily opened on a horizontal axle. The ventilation of the kitchen and the laundry is effected by means of the draft through the steam chimney, which is an iron smokepipe set up in a wide ventilating chimney of masonry. The construction of this chimney is the same as that of the pavilion chimneys, which will be described later.

The cooking is done by steam, except roasting.

In close connection with the kitchen are the rooms for cleaning the vegetables and washing the utensils. In the room for washing dishes is a double cast-iron washing basin, 1.25 metres wide and 2.50 metres long. Near these rooms is a large dining room which is under the control of the chief cook. Farther on is the office of the steward, and the dining room for the kitchen girls, twelve in number.

In the first story above the offices just described are the dormitories for the maids, and the rooms of the chief cook. The maids' alcoves are separated from each other by low wooden partitions, and closed with curtains. The remaining space on this end of the building is for kitchen stores.

The space between the kitchen and laundry, on the first floor, is used for rooms for stokers and servants, and for storage rooms for the kitchen; besides, a tank for hot water, heated by exhaust steam, supplying the kitchen and the laundry.

The ground plan of the southern half is like that of the northern. The rooms adjoining the laundry are set apart for soiled linen, and

for mangle and ironing rooms. Another office is near the northern entrance for the wash inspector ; here also is a dormitory for twelve wash girls. The sleeping places for the latter and the apartments for the head washerwoman are in the first story, and are arranged like those in the southern part of the building for the attendants of the kitchen. There is also a storeroom for the wash of the establishment.

Over the whole southern half of the building extends a drying room, that can be heated. It is 2.20 metres high, inside measurement.

DESCRIPTION OF THE BUILDINGS FOR THE SICK.

THE FOUR ONE-STORY PAVILIONS OF THE SURGICAL DEPARTMENT.

These buildings are not in all respects the same. In the two buildings first constructed two different systems of heating were introduced for the purpose of comparison. In the two pavilions erected later the system that the experiments had proved most serviceable was introduced, with, however, some slight modifications. But this had no effect either on the outward appearance or on the arrangement or use of the space of the interior of the buildings.

The buildings, placed north and south, have a length of 35.15 metres, breadth, 10.36 metres, to which are added, on each end, wings projecting 3.45 metres, with a depth of 7.53 metres. In one of the ends is the principal entrance ; at the other end the day room, projecting 2.67 metres, with a width of 9.10 metres ; from this, again, projects the piazza, 8.79 by 3.61 metres. The ventilating chimney, built in the day room rises, together with its iron cap, 9.50 metres above the roof of the building. The roof, which projects 1 metre beyond the walls, is covered with slate. The roof of the piazza has an iron frame on iron supports, and is covered with corrugated zinc. The walls are covered with tiles of a light red color, the effect of which is enlivened by stripes of a yellowish color. The windows and doors are bordered with the same yellowish color. The cut stone cornices are also yellow. Under the principal cornice is a green frieze. The window sills are slabs of slate.

In order to secure the greatest possible amount of natural ventilation, there have been placed on each side of the large wards (east and west) windows reaching close up to the ceiling ; and single rooms have been so placed in the corners of the buildings that two windows could be placed in the walls, adjacent and at right angles to each other.

Since the attendants can not with safety be depended upon to use carefully the possible means of ventilation, there is in each ward an indicator by means of which the degree of ventilation can be known at any time. The physicians are thus enabled to see at a glance and rectify any carelessness in this respect.

The following is to be noticed in the distribution of space for the thirty-two beds in the one-story pavilions: The principal entrance leads, by a stairway of four steps, into a kind of vestibule connecting directly with the main ward, affording access to the single rooms in the front part of the building. The ample proportions of this vestibule give room for closets for linen and utensils. In two of the surgical pavilions, operation rooms are placed in this part of the building. There are, besides, the tea kitchen, the attendant's room, two single rooms, a closet with sink, and a staircase communicating with the basement below, and a low story in the roof. This upper story contains two more isolated rooms, together with closet and sink, and an apartment of two rooms for an assistant physician.

There are, therefore, in the four buildings of the surgical department, eighteen isolated rooms. Two of these contain two beds each, making in all twenty isolated beds. Only four beds in each pavilion were needed to give with the number (twenty-eight) in the wards the required thirty-two per pavilion. It is thus always possible to give each isolated room a thorough cleaning and airing.

The large ward is 29.66 metres long and 9.10 metres wide, and contains twenty-eight beds. The beds are so arranged as to leave a passage 4.08 metres wide in the middle of the room. They are placed in front of the window posts, distant 0.93 metre from the outside walls, so that the patients are not in a direct draft. The height of the room, with a ceiling gradually rising toward the middle, averages 5.96 metres; so that each patient has

$$\frac{29.66 \times 9.10 \times 5.96}{28} = 57.45 \text{ cubic metres}$$

of air, while, in the judgment of medical men, the minimum required varies from 46.37 to 61.83 cubic metres. The ward can be inspected, by means of small windows, either from the tea kitchen or the attendants' room. In the opposite end a double glass door leads into the day room, which is 8 by 7.22 metres, and through which the patients can be rolled in their beds onto the piazza.

Near the day room is, on one side, the bath room and wash room, and on the other a room containing two closets, a urinal, and a sink. The bath and wash room contains two stationary enameled cast-iron tubs and a shower bath; a portable zinc bath tub, the wheels of which have rubber tires; four tilting enameled cast-iron wash basins let into a slate slab, and an arrangement for heating bath linen.

A flight of steps connects with the heating apparatus in the cellar and one with the top story. This top story contains, over the day room, a room for attendants; next to this, over the bath room, the reservoir for warm water and room for storing clothing brought by patients.

Since the required amount of room did not necessitate a cellar

under the whole building, this was confined, in the pavilion first erected, to the corner; in the second pavilion, the method of hot-air heating necessitated a passage under the whole length of the building, and the same thing was done for the two pavilions last erected, because the system was very easy to manage and the extra cost very slight. The cellar under the middle part of the building is taken up with the channels for fresh air and the two heating rooms, the larger one of which extends the whole length of the ward. Near these, between the double arches, are the channels for carrying off the foul air. Under the day room are the heating apparatus, room for storing fuel, and a heat room; whilst under the principal entrance are three rooms for attendants (in two pavilions this space is given to a morgue), a reception bath, and a room for mineral water.

It seemed advisable to build the walls solid, of porous brick, and to cover the inside with plaster, which was painted. This was done both for the purpose of keeping an even temperature inside and to avoid as much as possible the use of wood, the unavoidable cracks and joints of which afford more opportunities for the penetration of microbes than a glazed, painted wall which can be washed. The ceiling, somewhat arched, is also plastered and painted. The window sills are of sandstone.

The floors in the pavilion first erected are of narrow oak boards, closely fitted together and varnished. However satisfactory such a floor may be under other conditions, for hospital wards, especially for surgical wards, such material should be used as absorbs no moisture, is easily cleaned, and is absolutely free from cracks. The tile made at Mettlach, laid in cement mortar, is the only available material that fulfills these conditions. Though a few voices were raised against its use, yet so many reasons recommended it that it was decided to pave the ground floors of all the pavilions with the tiles. The fact that the floors of the wards have under them hot-air ventilating passages diminishes during the use of heat the feeling of cold occasioned by the density of the tiles; then, again, every evil effect can be diminished by the use of rugs before the beds and of slippers for the patients. The floors of neighboring rooms, as passages, tea kitchens, bathrooms, closets, and piazzas are covered with the same tiles. On the other hand, the single rooms, attendants' rooms, and day rooms have pine floors.

The windows of all the rooms intended for patients are double, and so constructed that the upper part, close under the ceiling, can be partly opened on a horizontal axis, whereby in the upper strata of air a draft is established, harmless to the patient, which is a very beneficial arrangement. Whatever may be the merits of artificial ventilation, it will never have the efficacy of a steady, natural change of air independent of the care of attendants, and the activity of which is ten to twenty times that of artificial ventilation.

THE SIX TWO-STORY PAVILIONS OF THE DEPARTMENT OF INTERNAL DISEASES.

A comparison between the ground plan of the one-story pavilions and that of the two-story shows only a slight difference in the arrangement. All the other differences arise from the different requirements of the patients to be treated and the addition of another story.

The projection of 3.50 metres in the wings of the pavilions of the surgical department was in these pavilions cut down to 1.80 metres, which, to get the required area, resulted in increasing by 4 metres the length of the pavilion. By comparing the areas, the two-story pavilion will be seen to contain an increased area of 13 square metres.

The stairway to the second story is in the entrance hall, and shut off at the inner corridor, so that the upper story can be reached without going through the ground floor, and both stories can be completely isolated from each other. On the ground floor, near the stairs, on one side, are a reception room and a room for special investigations. On the other side is an isolated room. In the first story there are isolated rooms on both sides. In the roof story (low ceiling), on one side of the staircase over the entrance hall, near a room for attendants, there is a fourth isolated room, whilst on the other side is an apartment of two rooms for an assistant physician. All four isolated rooms are of the size required for two beds. The eight beds arranged for in the isolated rooms, with the twenty-eight beds in each of the two wards, make the required number—sixty-four.

The two wings of the day room, which contain the baths and the closets, are, when compared with those of the one-story pavilions, also 1.60 metres narrower, because two bath tubs and three wash basins on each floor were considered sufficient.

In order to secure the most complete separation of the stories, all the rooms, except the day room and the upper ward, are vaulted.

The lower piazza is also vaulted. The upper has a wooden roof frame, supported on massive pillars, and covered with corrugated zinc.

The finishing of the interior corresponds with that of the one-story pavilions; the floors of the lower wards are paved with Mettlach tiles, those of the upper wards, as well as of all the isolated rooms and the dwelling rooms, are of pine boards, 10 centimetres wide. For halls, bathrooms, closets, tea kitchens, and piazzas tiles are used throughout. The windows—all double—are made to open at the top, as in the one-story pavilions.

The basement contains in the entrance wing the reception bathroom and the lodging rooms of the attendants. In the two mid-

die pavilions, however, there are a morgue and a watch room. The rooms for attendants in these two pavilions are over the day room.

In the wards the space allotted each bed is 9.85 square metres. In the isolated rooms this reaches 12 square metres per bed. In the lower wards each patient has 49 ; in the upper, 52 cubic metres. In the isolated rooms it varies between 38 and 54 cubic metres.

The ground floor, to the crown of the arch, is 5 metres high ; in the first-story ward the ceiling, as in the surgical ward, rises from 5.33 metres on the sides to 6.50 metres in the middle. The isolated rooms of this story are 4.25 metres high ; the rooms of the top story are only 3.12 metres high, and yet the space allotted each bed is 38 cubic metres.

THE TWO-STORY ISOLATED PAVILIONS.

These two buildings have two stories, each story consisting of two separate parts; each part contains one room for eight beds, one for two beds, and a third for one bed. Each part has, therefore, accommodations for eleven patients, and each pavilion accommodations for forty-four patients.

Here are treated cancerous and eruptive diseases which should be withdrawn from the sight of other patients, eye diseases which have to be treated in dark rooms, and cases of typhus, scarlatina, and other infectious diseases. Epidemic infectious diseases are generally excluded, but during prevailing epidemics it may become necessary to admit them.

The two isolated pavilions, situated in the southern part of the inclosure, parallel with the other pavilions, are 41 metres apart, with the principal entrances opposite each other. The length of each pavilion is 42.40 metres ; depth, 11.15 metres. In the middle of the rear of each are the baths and closets, 10.40 metres long, and projecting 1.80 metres from the main building.

These pavilions are, in their architectural features and inner arrangements, like the others, except where the character of the diseases to be treated made changes necessary.

VENTILATION.

The fact communicated by Dr. Esse that the workmen on the roof of the "Royal Charity" could not stand the smell coming through the openings in the roof is a striking proof of the effectiveness of this mode of ventilation. When against this the objection is raised that such energetic change of air involves a corresponding expenditure for fuel, it may be answered that the cost of a few tons of coal is not too high a price to pay for the advantage of great salubrity in a hospital.

Accordingly, it is considered of great importance to have a system

of natural ventilation for the large wards. The covered opening running the whole length of the roof can be closed by means of flaps attached to the sides. A sort of shaft made of boards connects this with the interior of the ward. This shaft can also be closed by means of a horizontal flap. Both sets of flaps can be regulated from the garret. By means of this arrangement and the windows already mentioned the amount of natural ventilation can be increased or diminished at will. It should also be noticed that every movement in the outer air, even the slightest breeze, creates a draft in the roof openings, because when the wind strikes the roof its direction is changed and it blows through the openings of the ventilator, carrying with it the air from the ward below.

In cold weather the admission of fresh air has to be differently managed, because it has to be brought already warmed into the room. Therefore, roof ventilation is practicable only so long as the temperature makes heating unnecessary. As soon as heating is necessary the flaps in the roof are kept closed. In the plans the artificial ventilation was to furnish 61.85 to 77.29 cubic metres of air per bed per hour. This quantity of air exceeds the space allotted each bed, which is 57.45 cubic metres, so that in less than an hour the air should be completely changed.

This requirement was satisfied by the erection of the following system of ventilation: The hot air coming from the warm rooms in the cellar rises, on account of its lightness, directly to the ceiling of the ward; gradually cooled by contact with the windows, it falls to the floor. Here it is drawn off through latticed openings placed in the walls, between the beds, into pipes which lead to the ventilating chimney. In the middle of this chimney is a cast-iron smoke pipe. The heat of the escaping smoke rarefies the air in the ventilating chimney, whereby so strong a draft is created as to necessitate placing a valve in opening of the chimney. Besides the heat of the smoke, the force of the wind has great effect upon the draft of the chimney.

When there is very little or no wind, and the heating apparatus is not working, it is sometimes necessary, for the proper ventilation of the ward, to use a small stove set up in the warm room in the cellar. A fire kept in this stove for 6 or 8 hours is sufficient to rarefy the air in the ventilating chimney. The use of this stove is especially necessary during the night in spring and fall, when the cold prevents the use of the roof ventilation.

THE BATH HOUSE.

Since there are bath tubs on each floor of the hospital buildings, it was necessary to provide in this building (which should be as centrally located as possible) only for the Turkish steam bath and the Roman bath.

The small building, occupying but 162 square metres of ground, and without cellar, resembles the other buildings in general appearance.

The door fronting the institution leads to a small vestibule, opening into the room of the bath attendant, the closet, the stairway leading to the garret, and the disrobing room (frigidarium) 6.25 metres square. The frigidarium, which contains six disrobing cells, separated by low board partitions and curtains, has on one side the Roman bath (tepidarium, sudatorium, and lavarium), and on the other the steam bath, reached through the lavarium, which is intended to be used in connection with both. All the ceilings are arched and the walls hollow. The building is heated by steam from the boilers of the administration building. The air in the sweating rooms is heated by steam coils under the floor, to which air from the outside is admitted and distributed through registers in the floor along the walls of the tepidarium and sudatorium. The other rooms are heated by radiators surrounded by wire screens.

To prevent the cooling effect of side windows, the tepidarium and sudatorium are lighted by small skylights. The ventilating ducts passing through the skylights terminate above the roof with Wolpert tops, and may be closed by means of a valve in the ceiling. The ventilation of the lavarium and the steam bath is accomplished in a similar manner by tubes passing through the arched ceiling. The ventilating pipe of the frigidarium ascends in one of the partition walls.

The floors in the hall and in the sweating rooms are made of Mettlach flagging. The wash and steam rooms have floors of planed laths, under which a tile floor, considerably inclined, serves to carry off the water. In the other rooms pine floors are used. The walls and ceilings are painted. To avoid as much as possible the use of iron and wood, brass mountings are used, and instead of double doors thick woolen hangings have been provided. The lavarium contains besides a bath tub all the necessary appliances for the douche. The steam bath is provided with steam valves at appropriate places, as well as with a steam douche. The reclining benches are arranged in tiers and are made of oak planks.

The garret contains a small heating tank and serves for drying towels, etc.

THE CORPSE HOUSE.

This building is 34.50 metres north of the administration building. To an elevated central building, 9 by 15.90 metres, are attached on both sides wings 6.45 by 10.35 metres. On the ground floor of the former is the chapel used for funeral services, 7.65 metres square, arched roof, stained-glass windows, and suitably decorated. The west wing contains two dissecting rooms, closets, etc. Since the

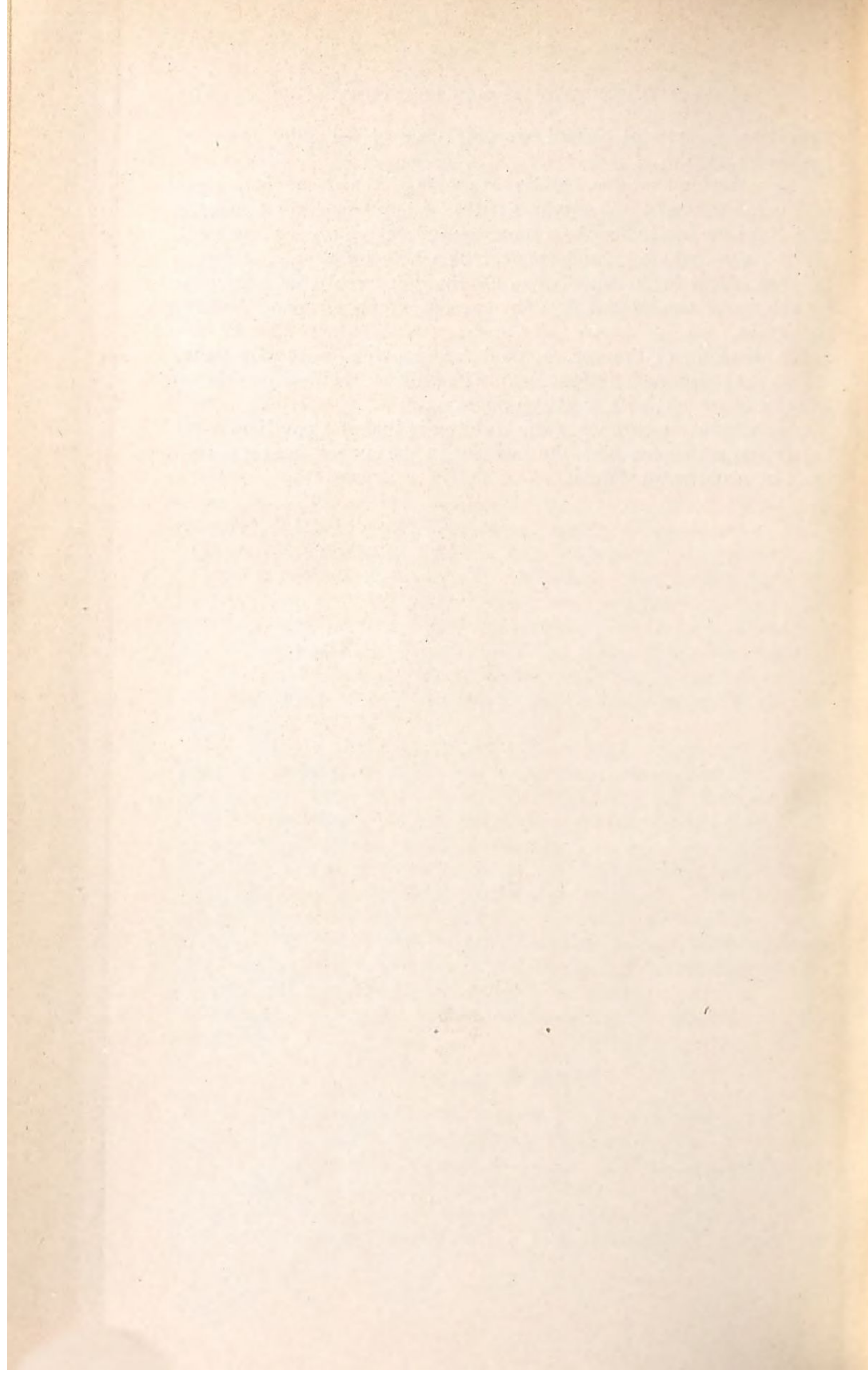
dissecting rooms and chapel are only used occasionally, they are heated by stoves.

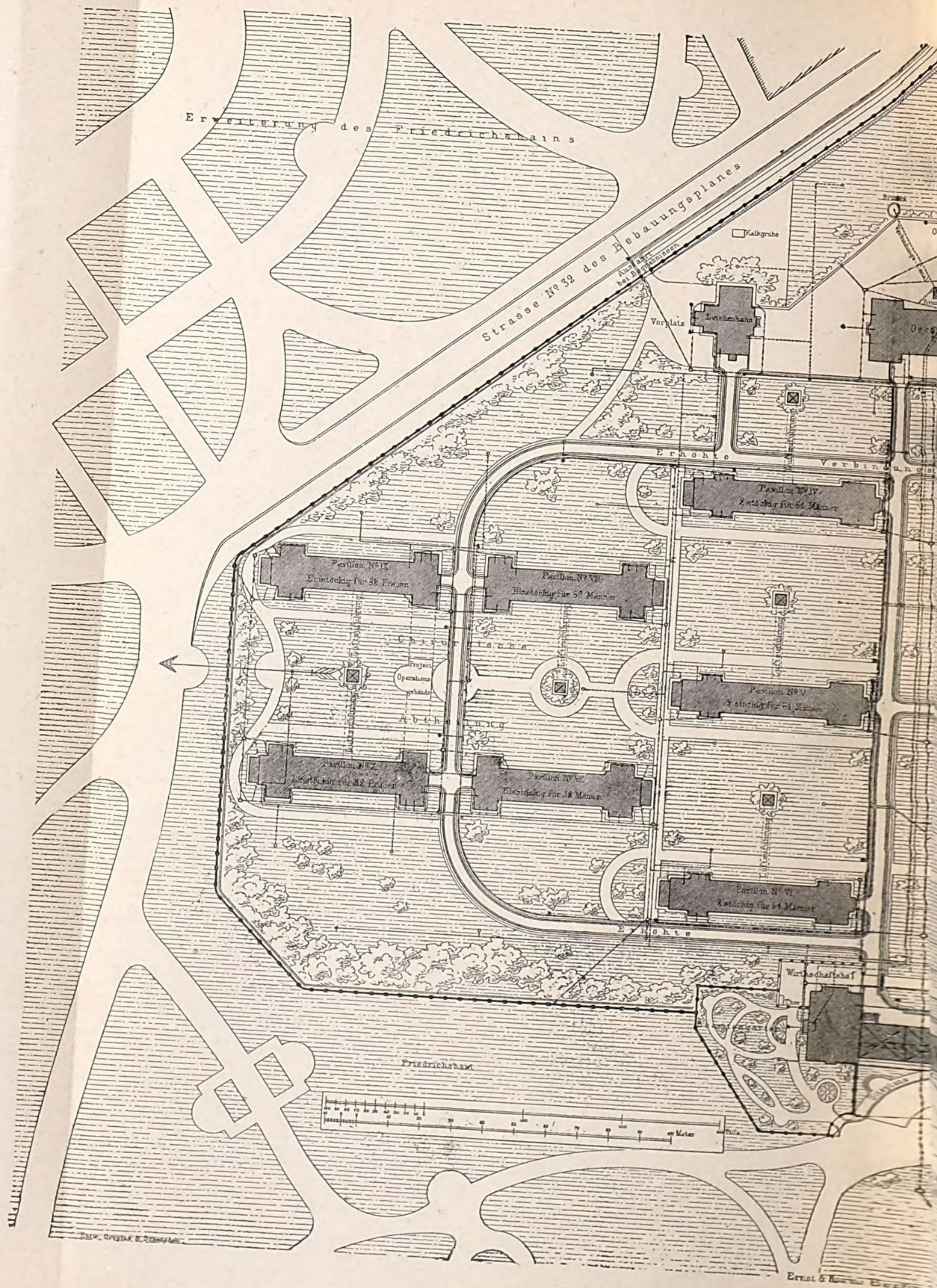
The east wing contains, besides the rooms of the attendant, a room which is intended to be supplied with the appliances for resuscitation. On the upper floor is a room for exhibiting preparations.

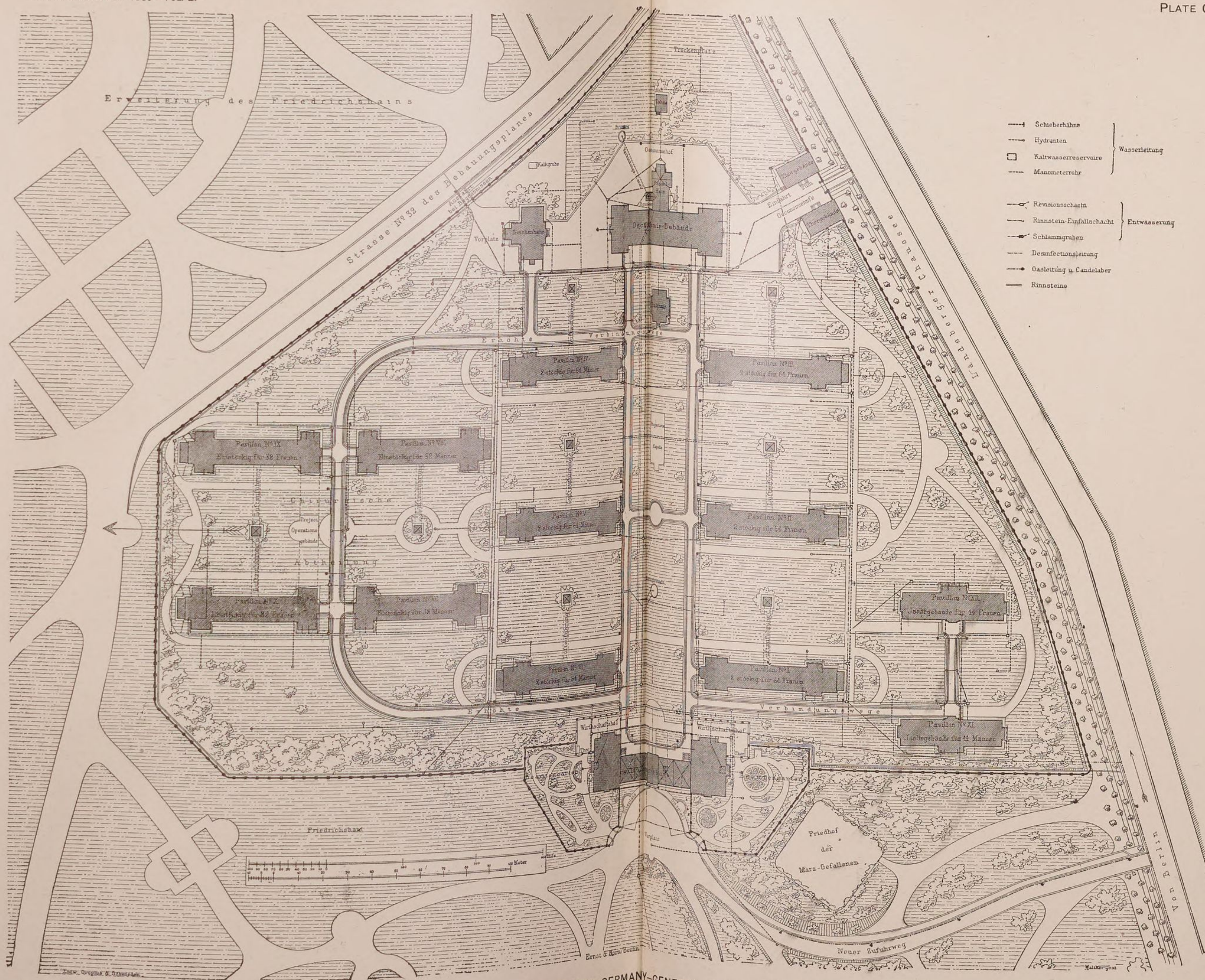
The cellar, which extends under the whole building, contains a morgue, rooms for keeping corpses, coffin room, coal bins, and cellar for the use of the attendant. The two latter entirely separate from the others.

The windows of the corpse rooms are provided with wire gauze to prevent the intrusion of insects. The walls and ceiling are painted and the floors laid with Mettlach flagging.

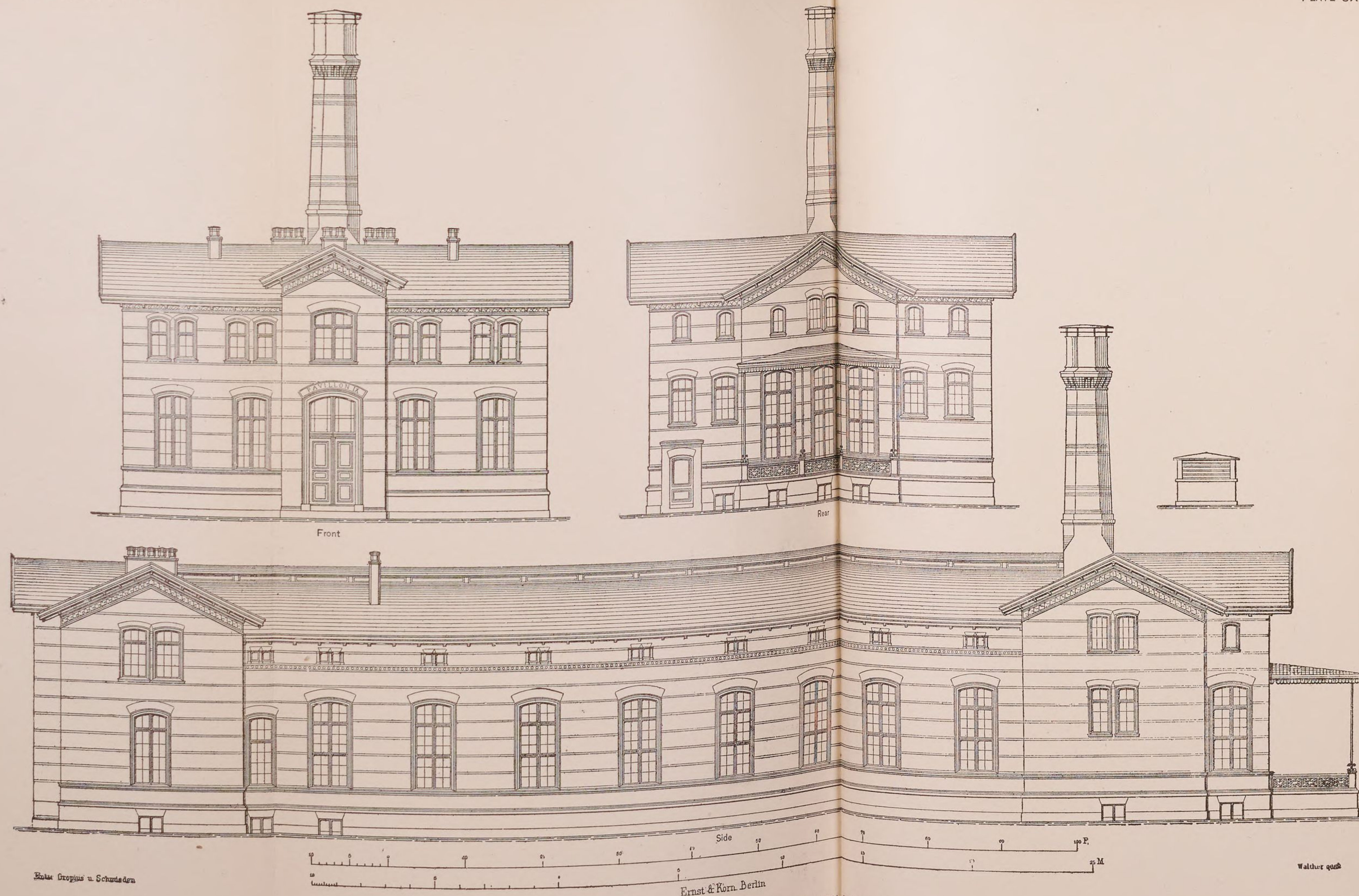
The external appearance of the building is that of a pavilion. But the front, which contains the entrance to the chapel, has somewhat more of architectural finish.



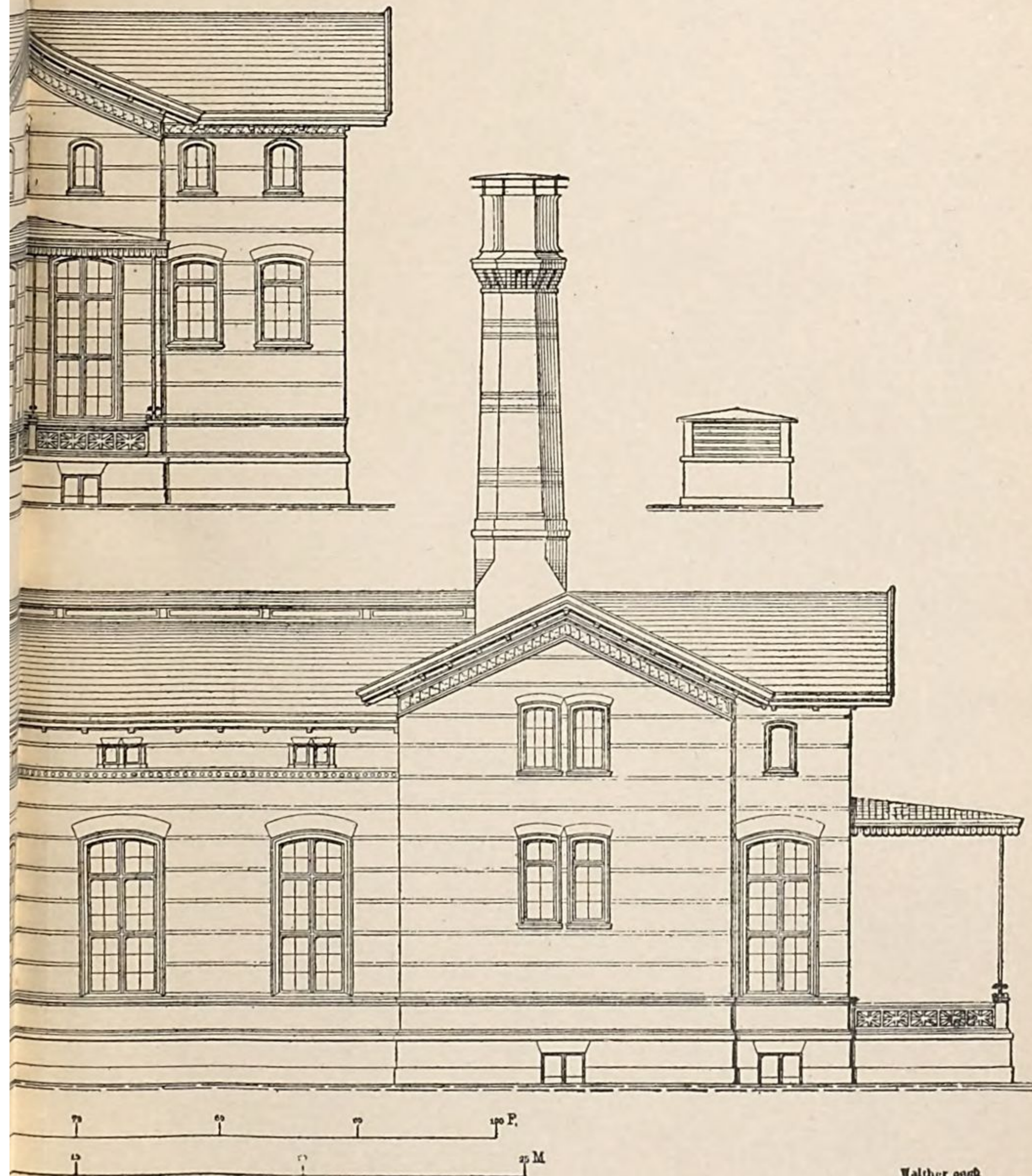




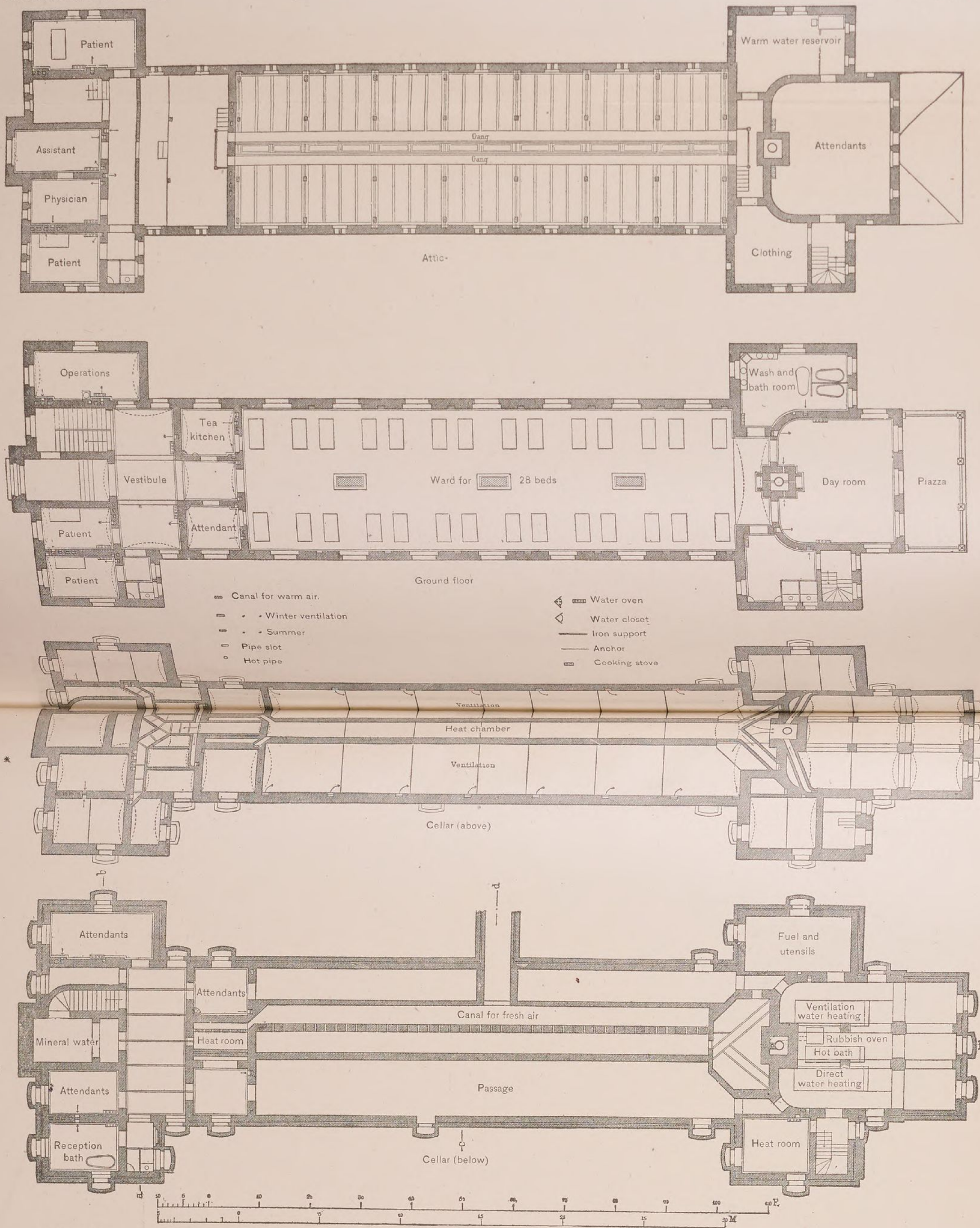
GENERAL CITY HOSPITAL, BERLIN, GERMANY—GENERAL PLAN OF GROUNDS.



GENERAL CITY HOSPITAL, BERLIN—ONE STORY PAVILION, ELEVATION.



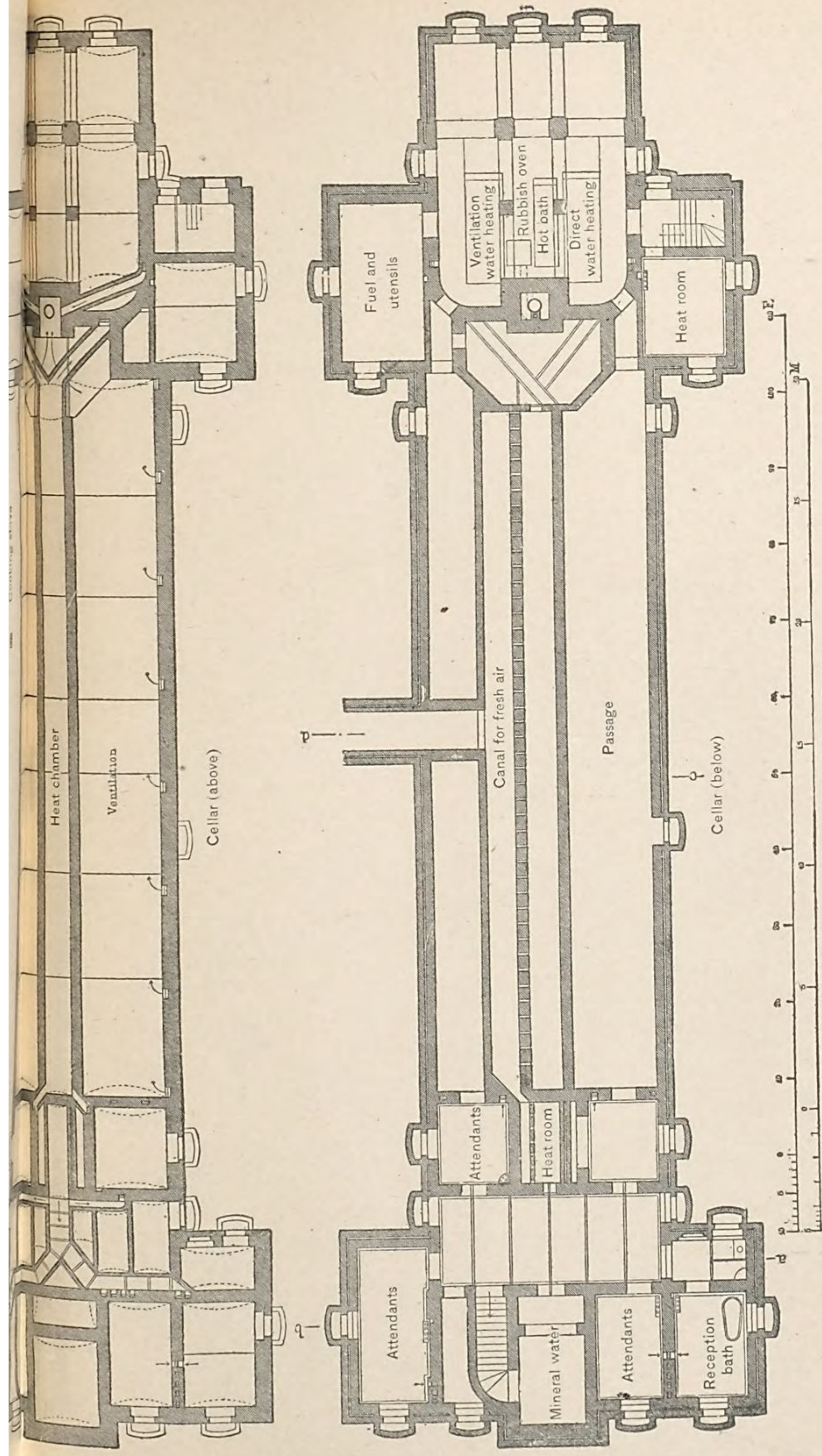
ELEVATION.



Entw. Gropius & Schmiedén

Ernst & Korn, Berlin

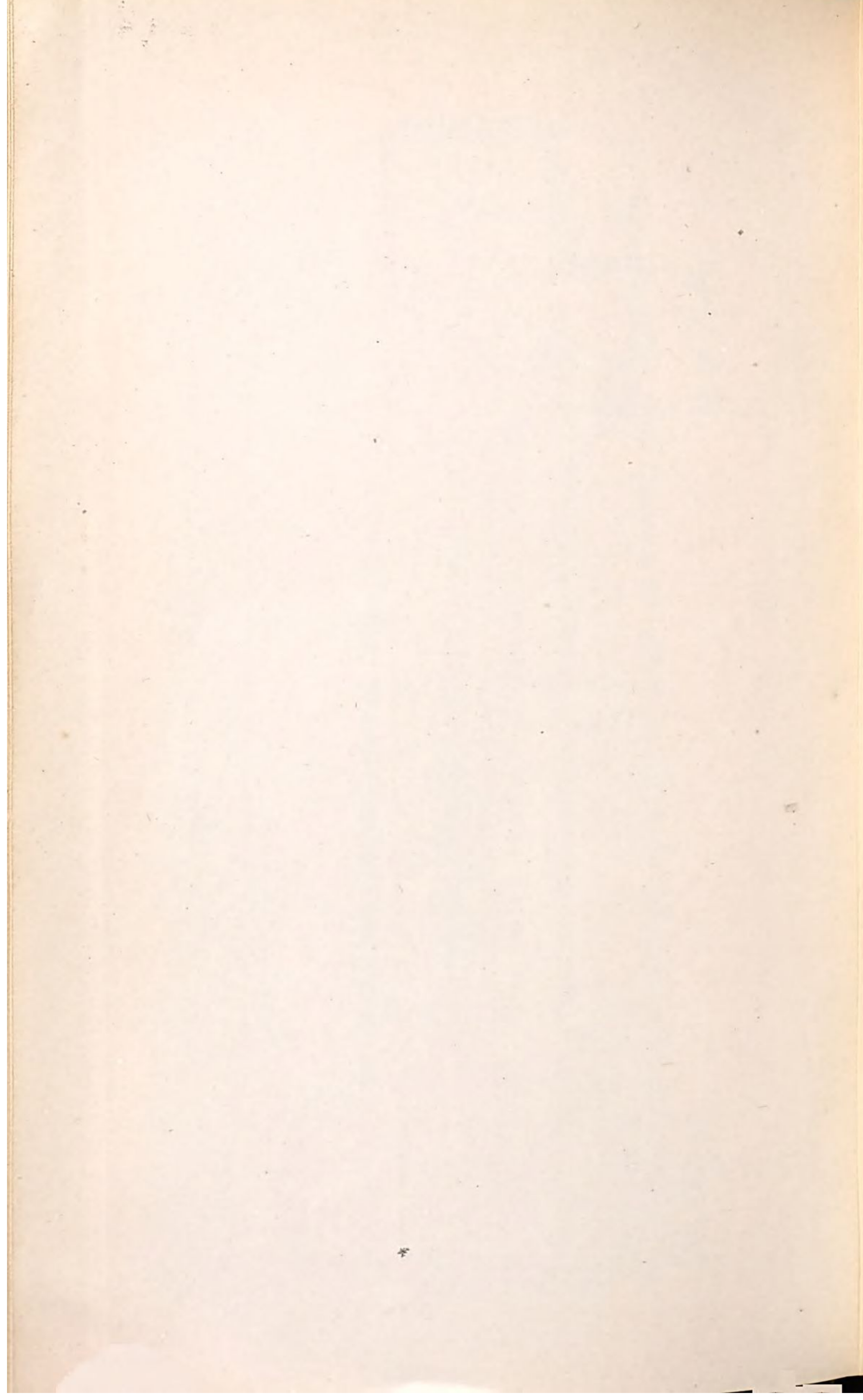
GENERAL CITY HOSPITAL, BERLIN—ONE-STORY PAVILION, 32 BEDS, GROUND PLAN.

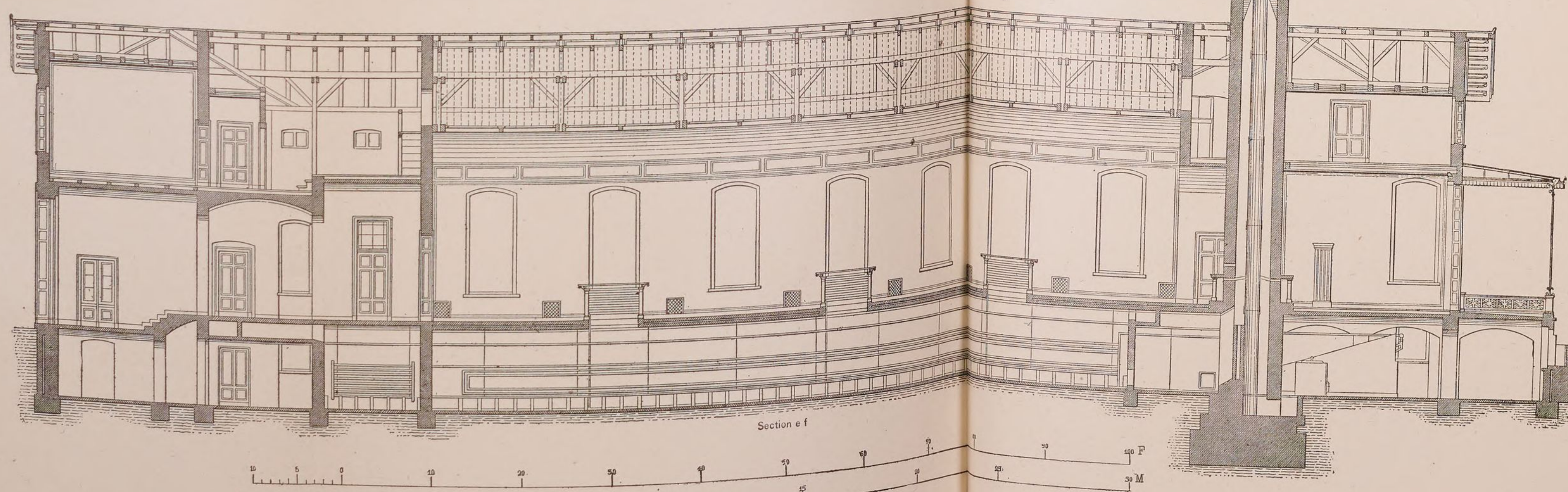
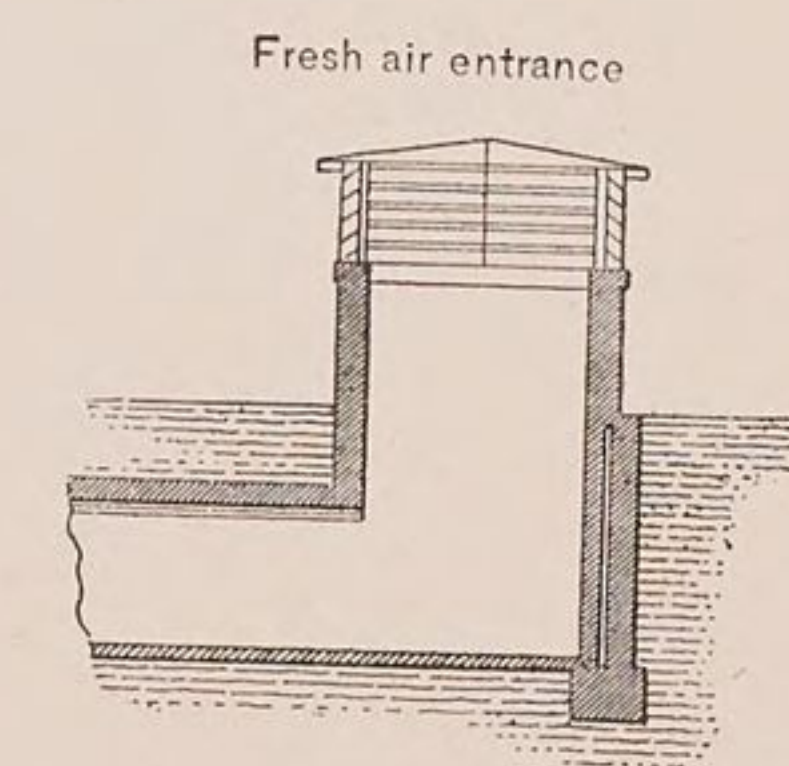
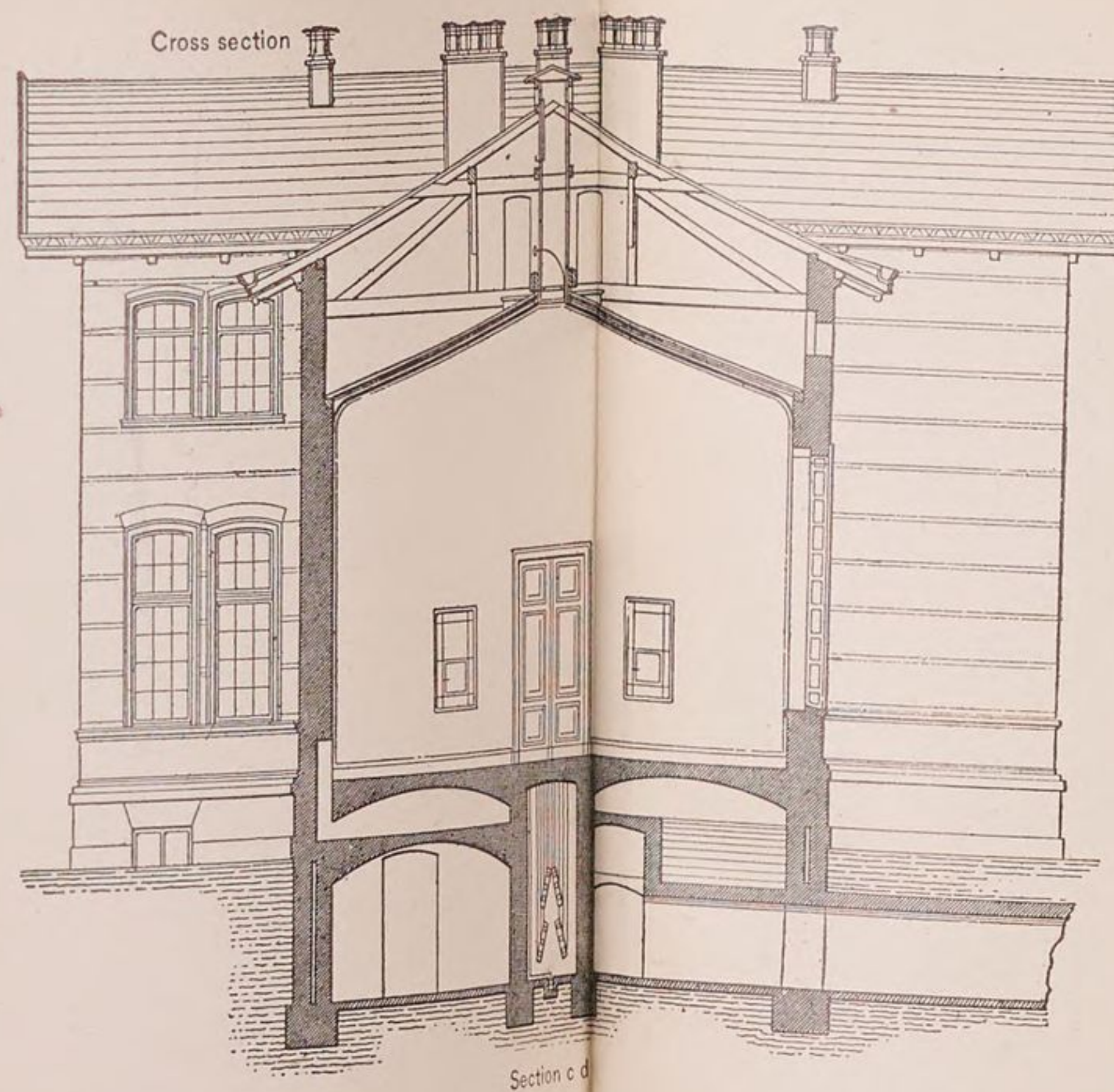
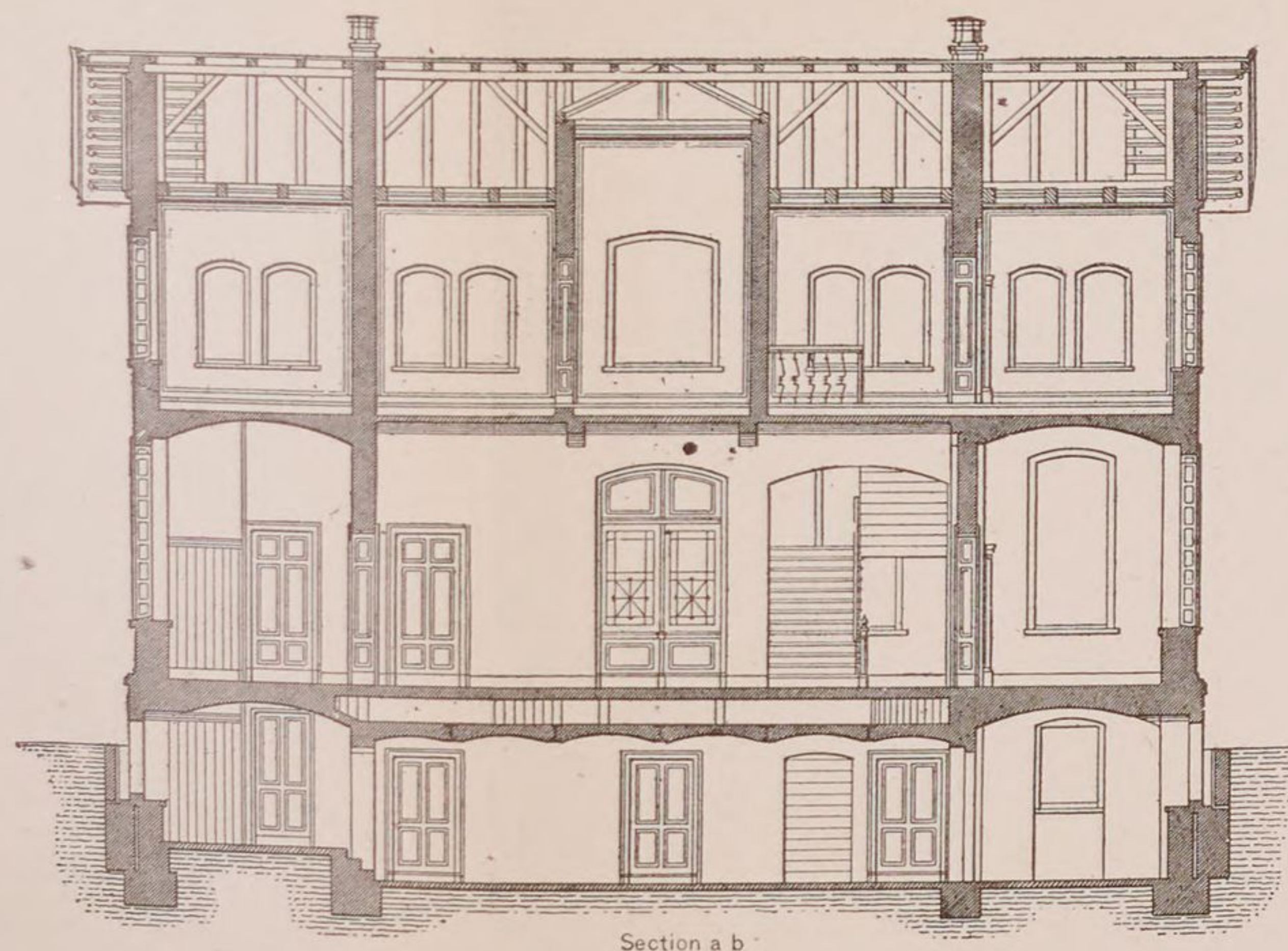


Entw. Gropius & Schmiedgen

Ernst & Korn. Berlin

GENERAL CITY HOSPITAL, BERLIN—ONE-STORY PAVILION, 32 BEDS, GROUND PLAN.



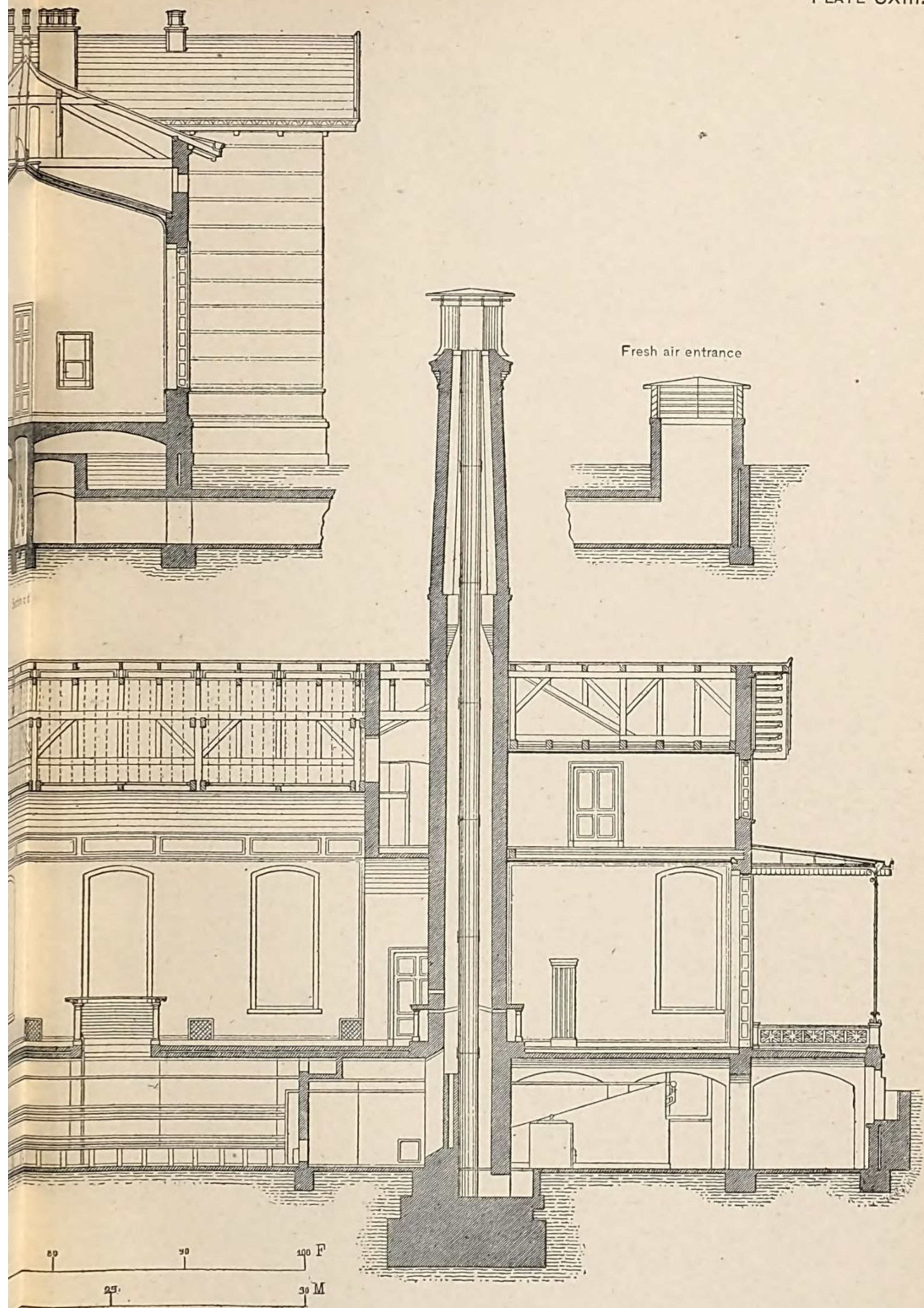


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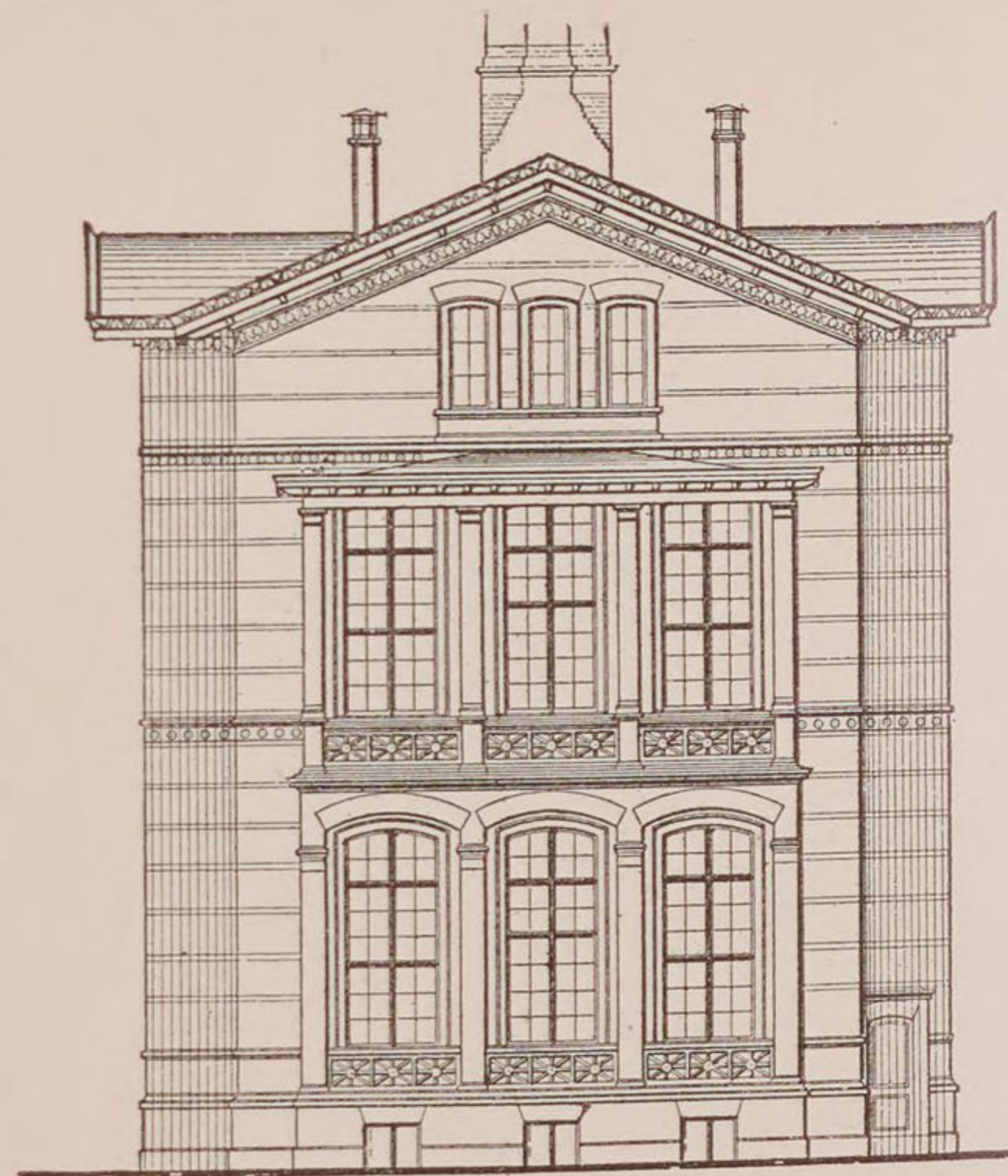
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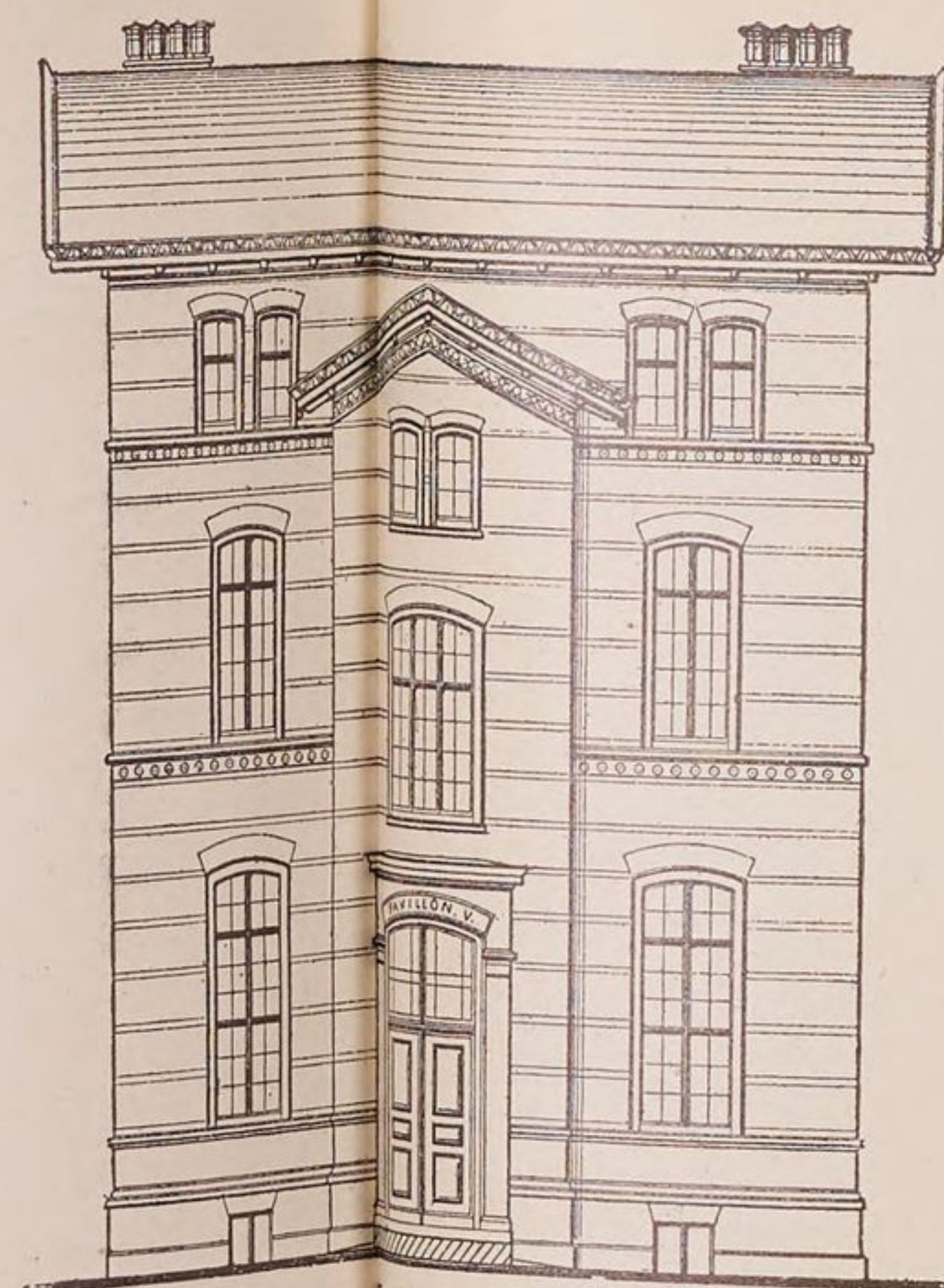
GENERAL CITY HOSPITAL, BERLIN—ONE-STORY PAVILION.



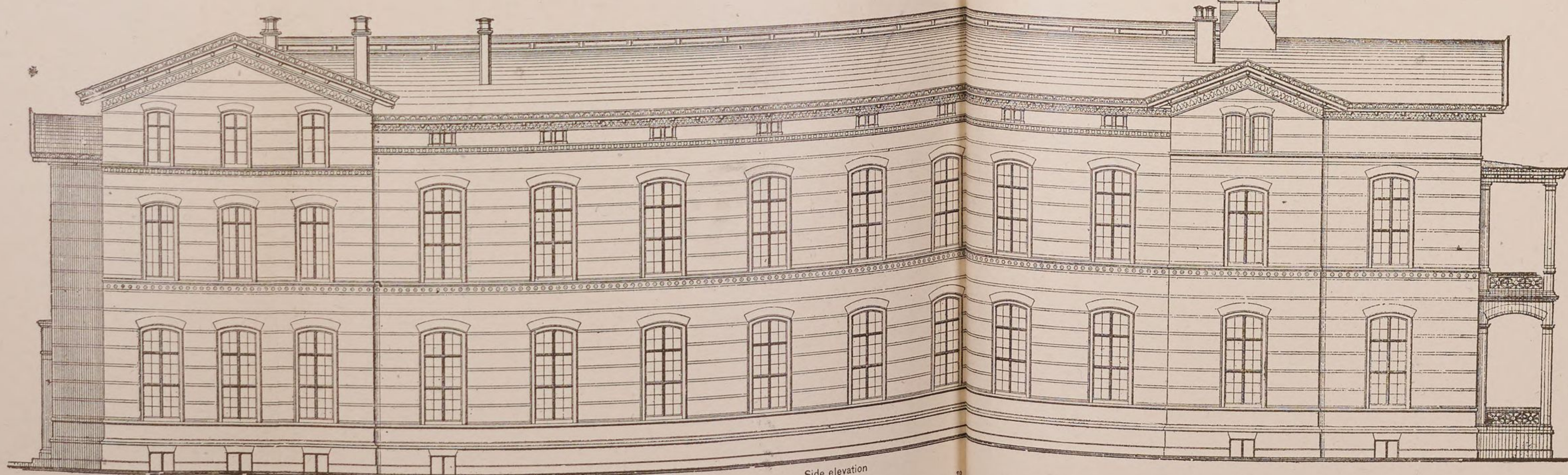
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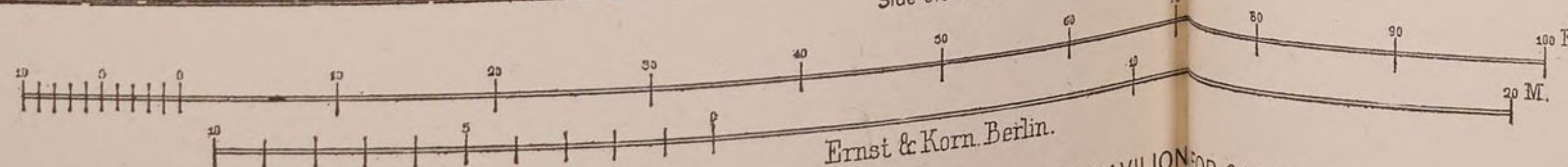
Rear elevation



Front elevation



Side elevation

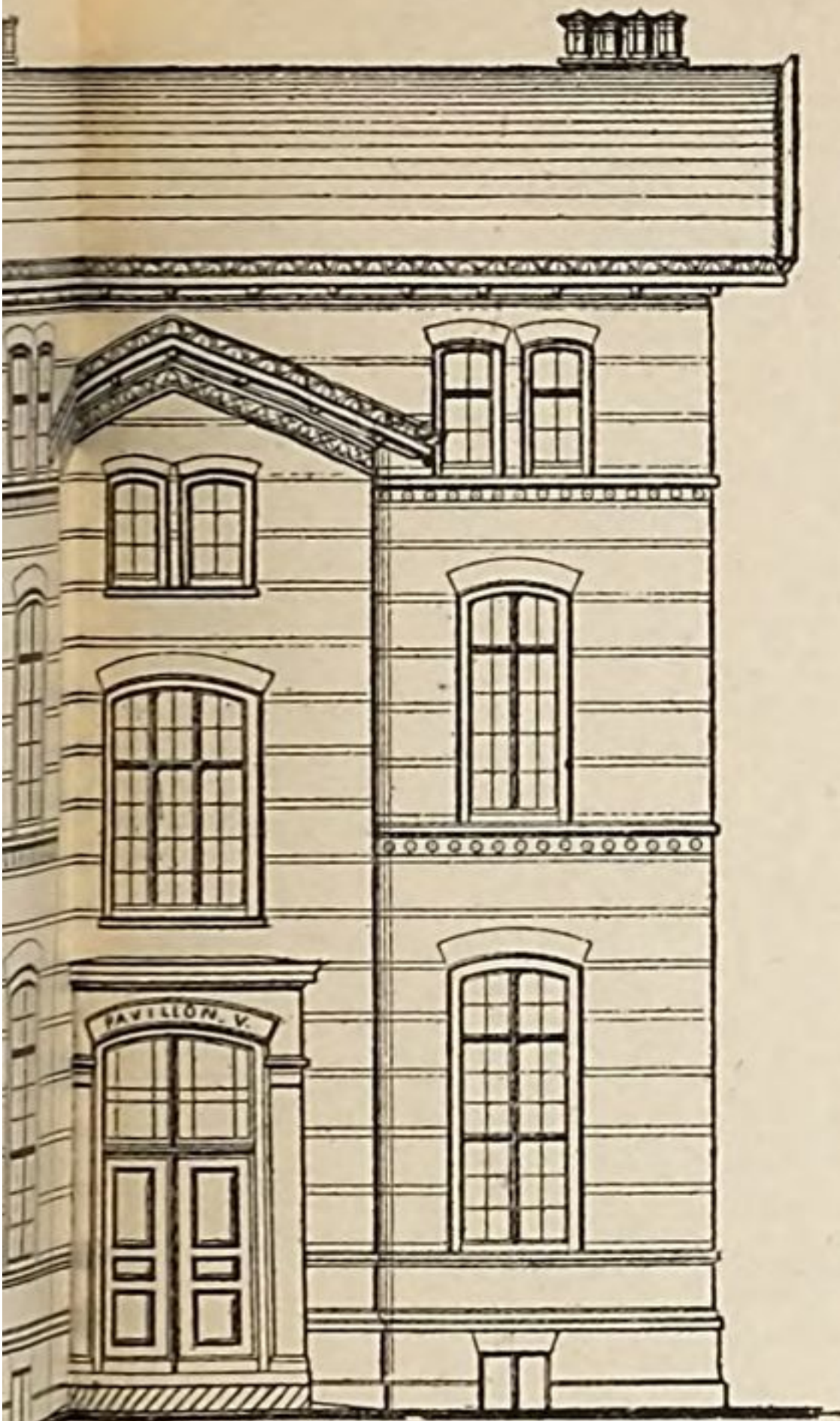


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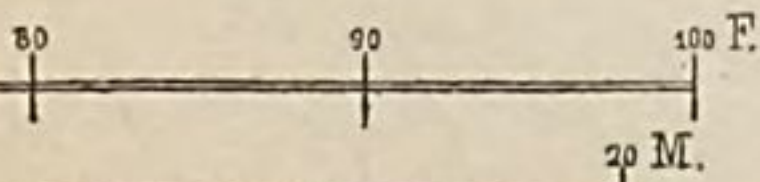
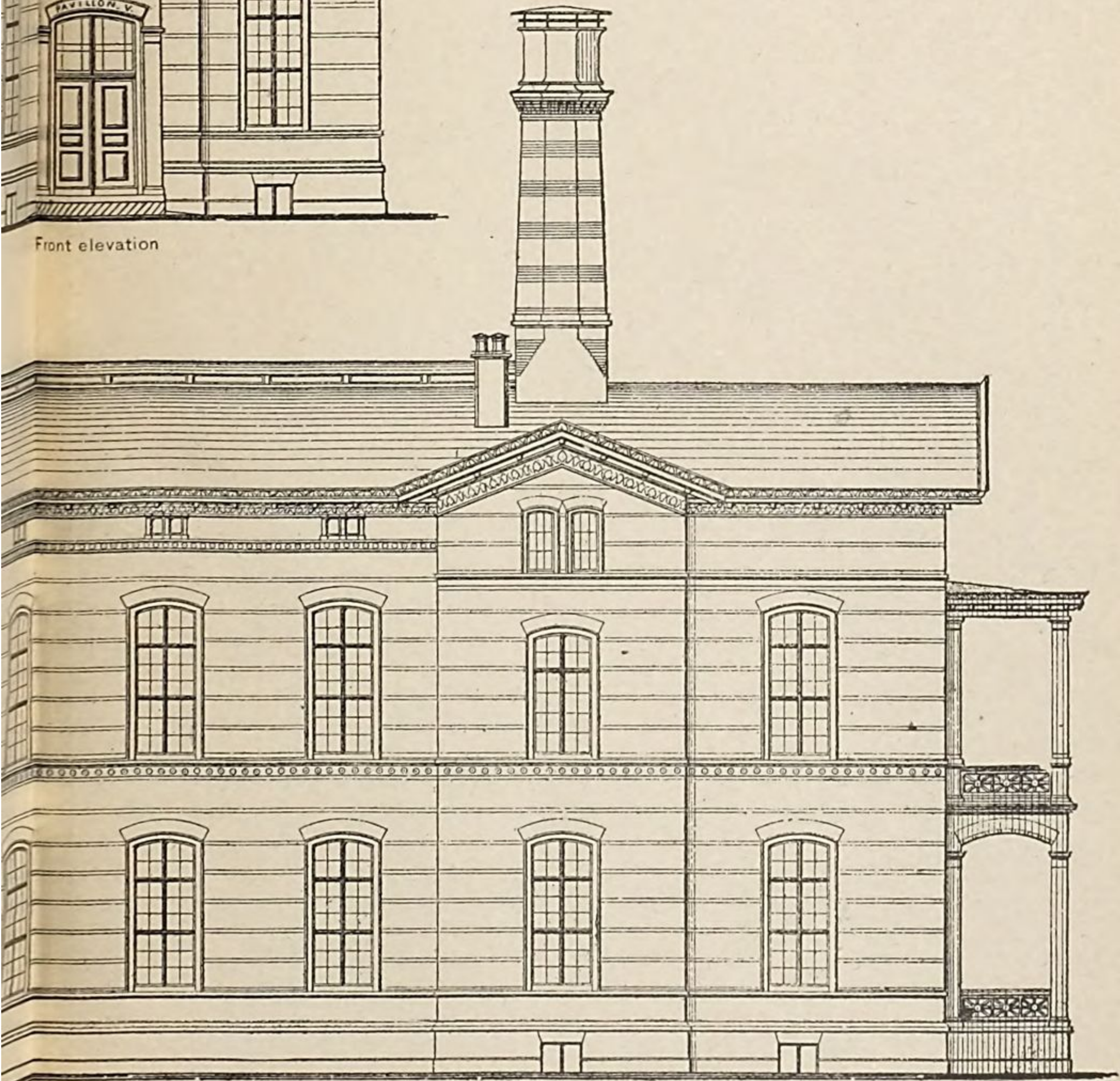
Ernst & Korn, Berlin.

Arch. Gehr. Ritter u. Meigel

GENERAL CITY HOSPITAL, BERLIN—TWO-STORY PAVILION FOR 64 BEDS.

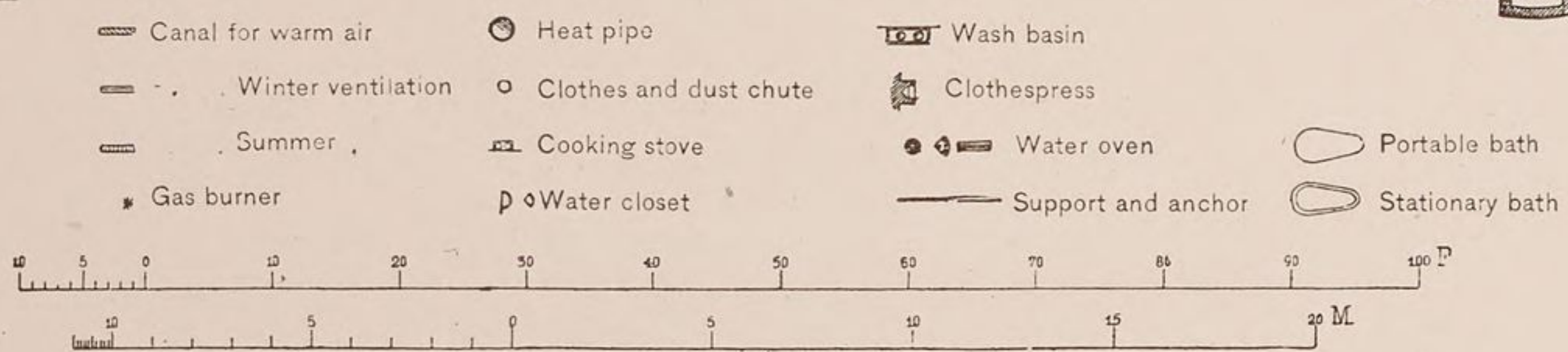
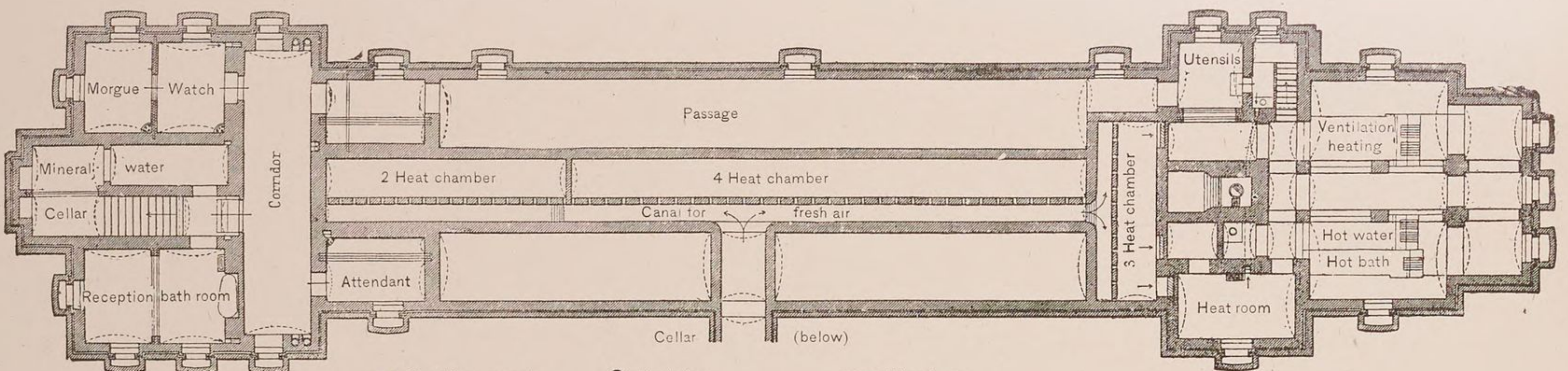
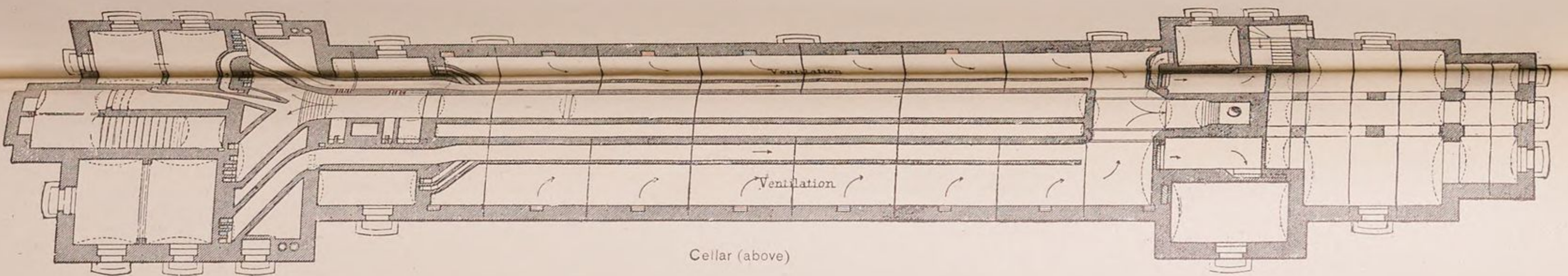
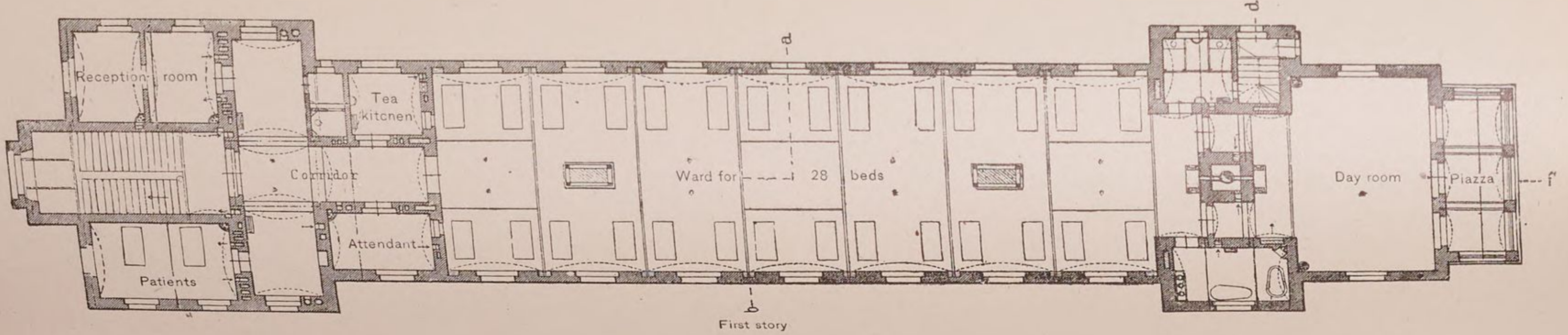
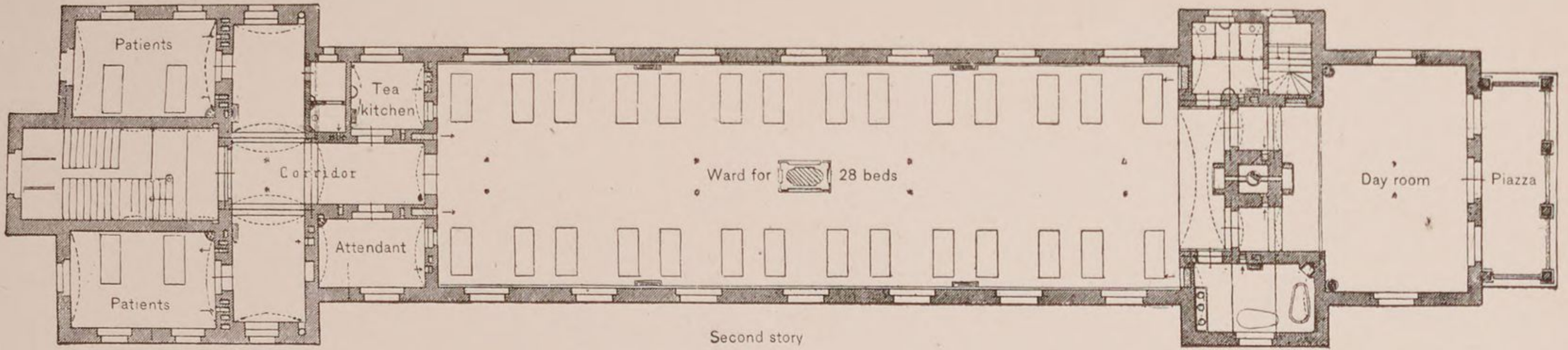
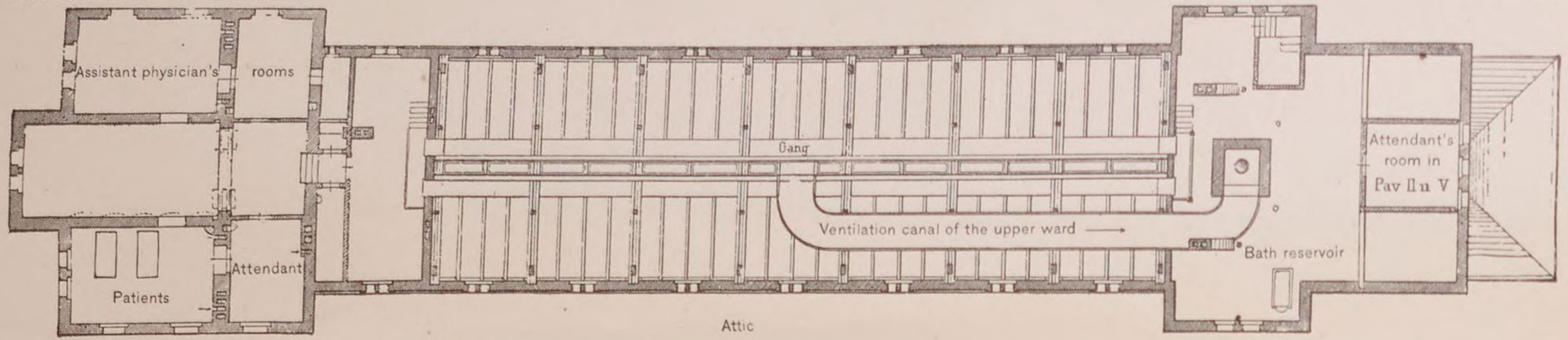


Front elevation



Arch. Gebr. Ritter u. Kugel

ION, FOR 64 BEDS.

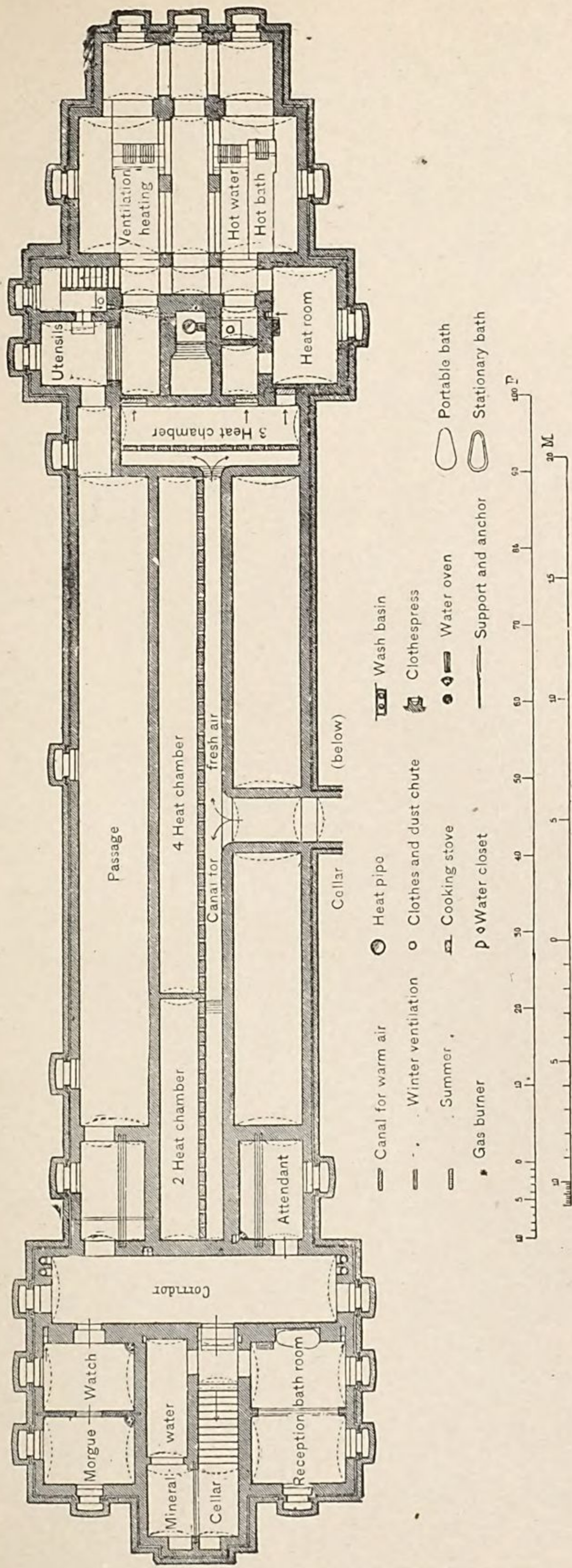
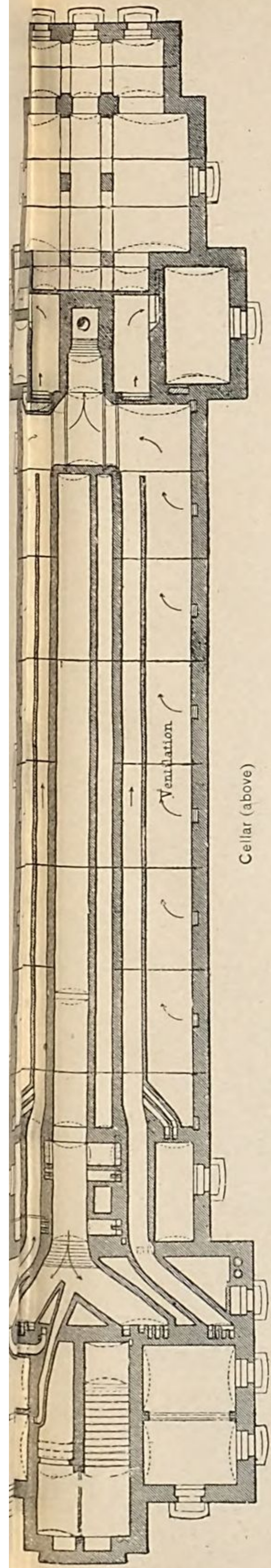


Entw. Gropius & Schmieden

Ernst & Korn Berlin

Walter gest.

GENERAL CITY HOSPITAL, BERLIN—TWO-STORY PAVILION, 64 BEDS.

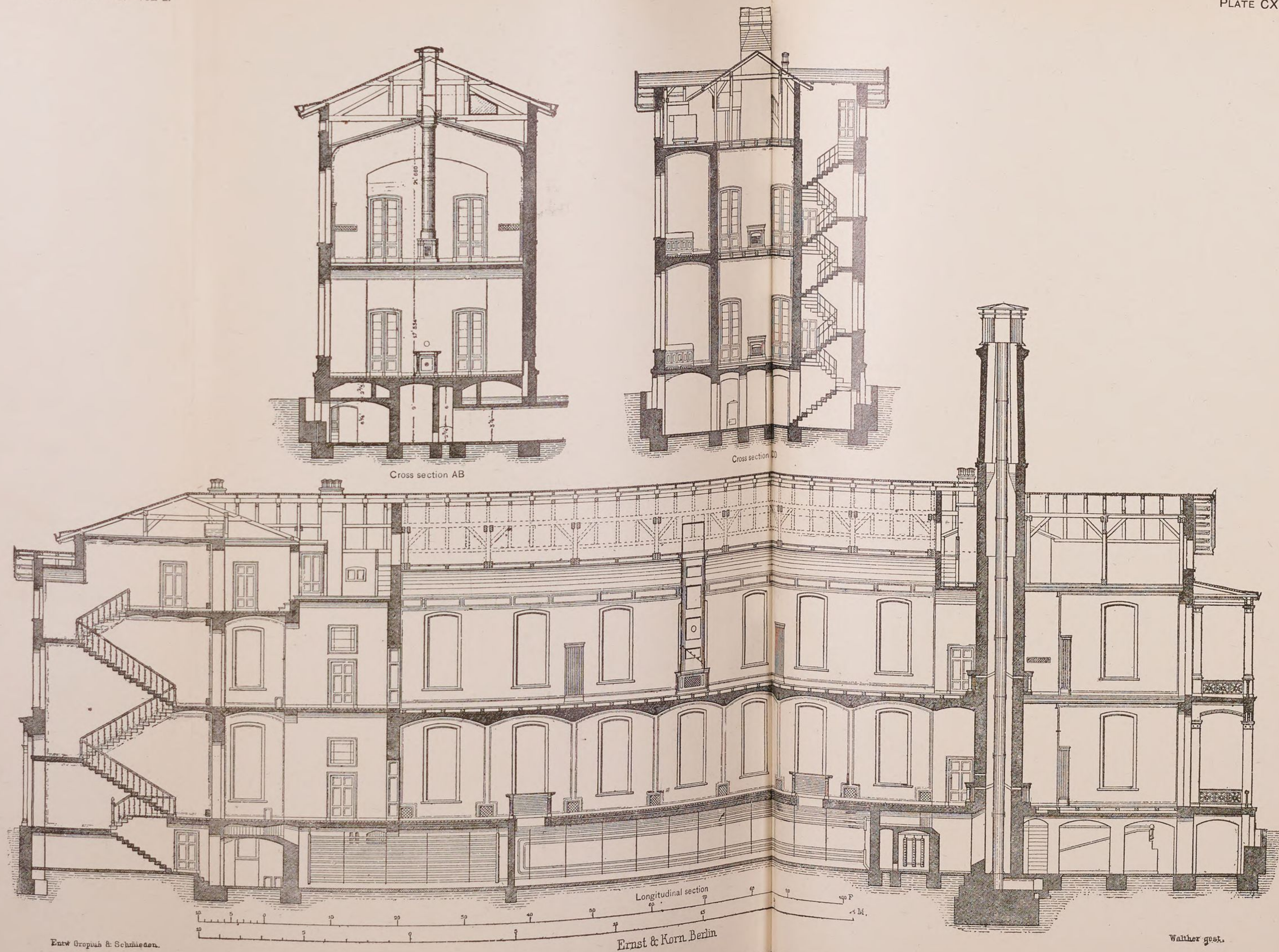


Ernst Gropius & Schmiedeknecht

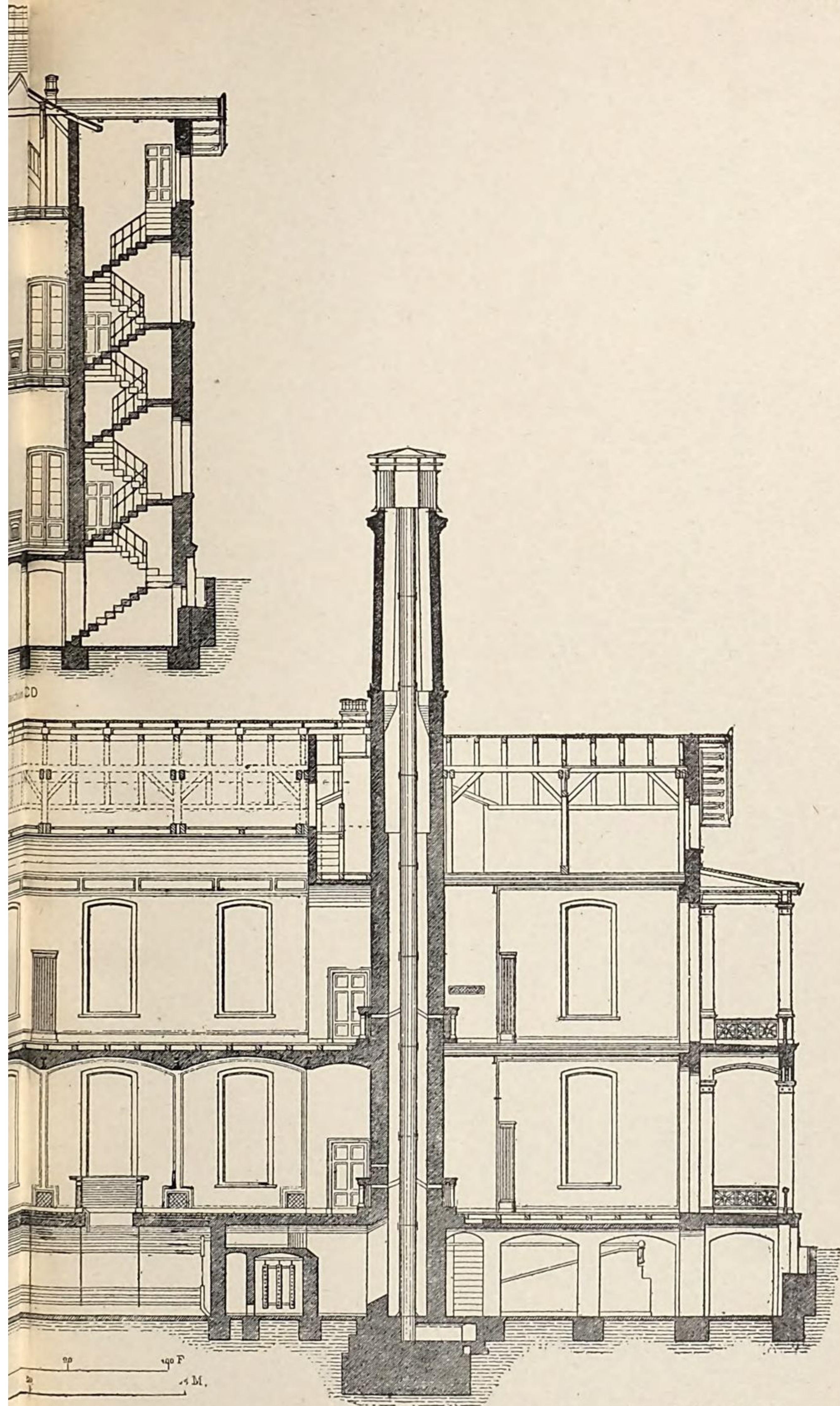
Ernst & Korn Berlin

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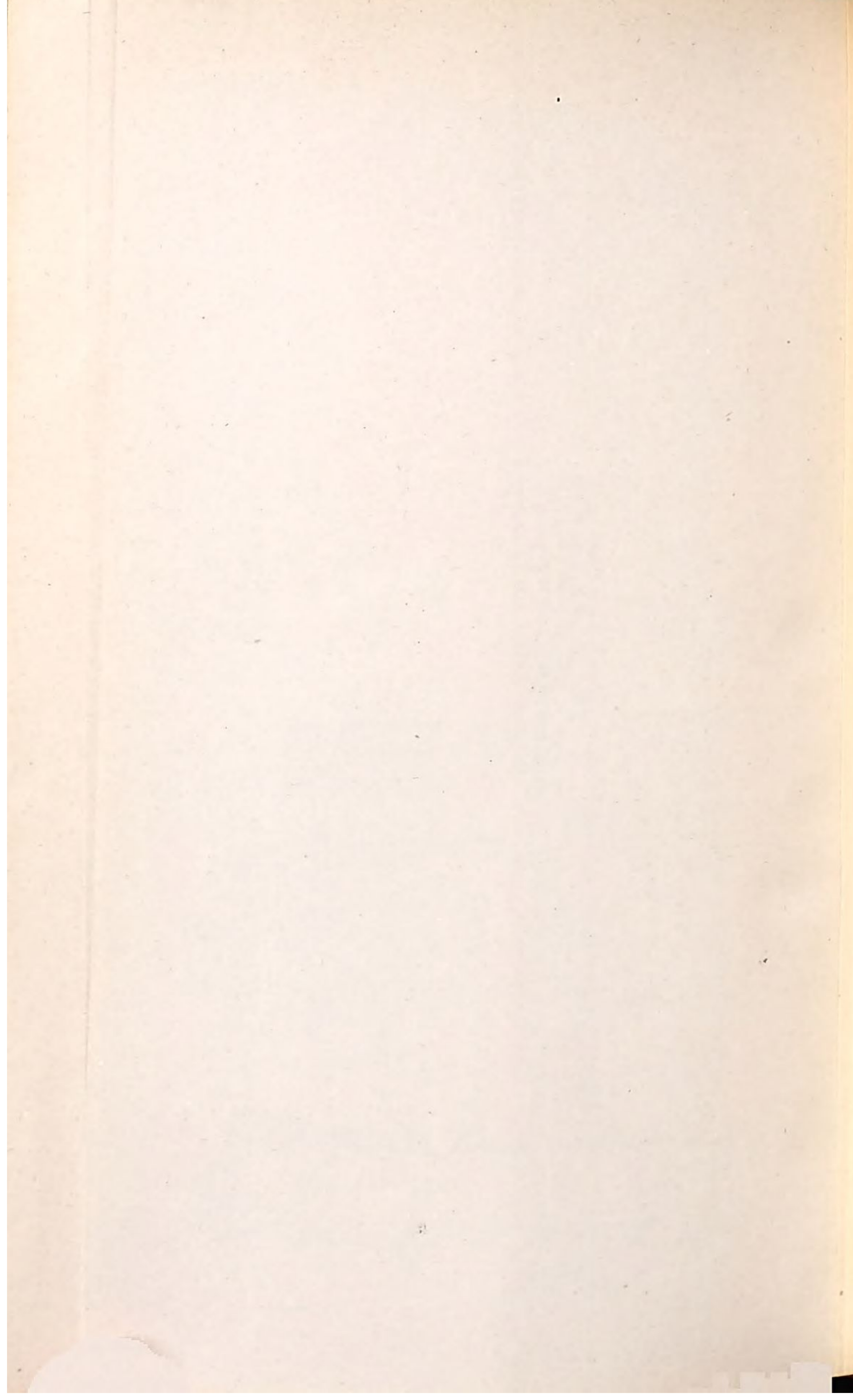
GENERAL CITY HOSPITAL, BERLIN—TWO-STORY PAVILION, 64 BEDS.



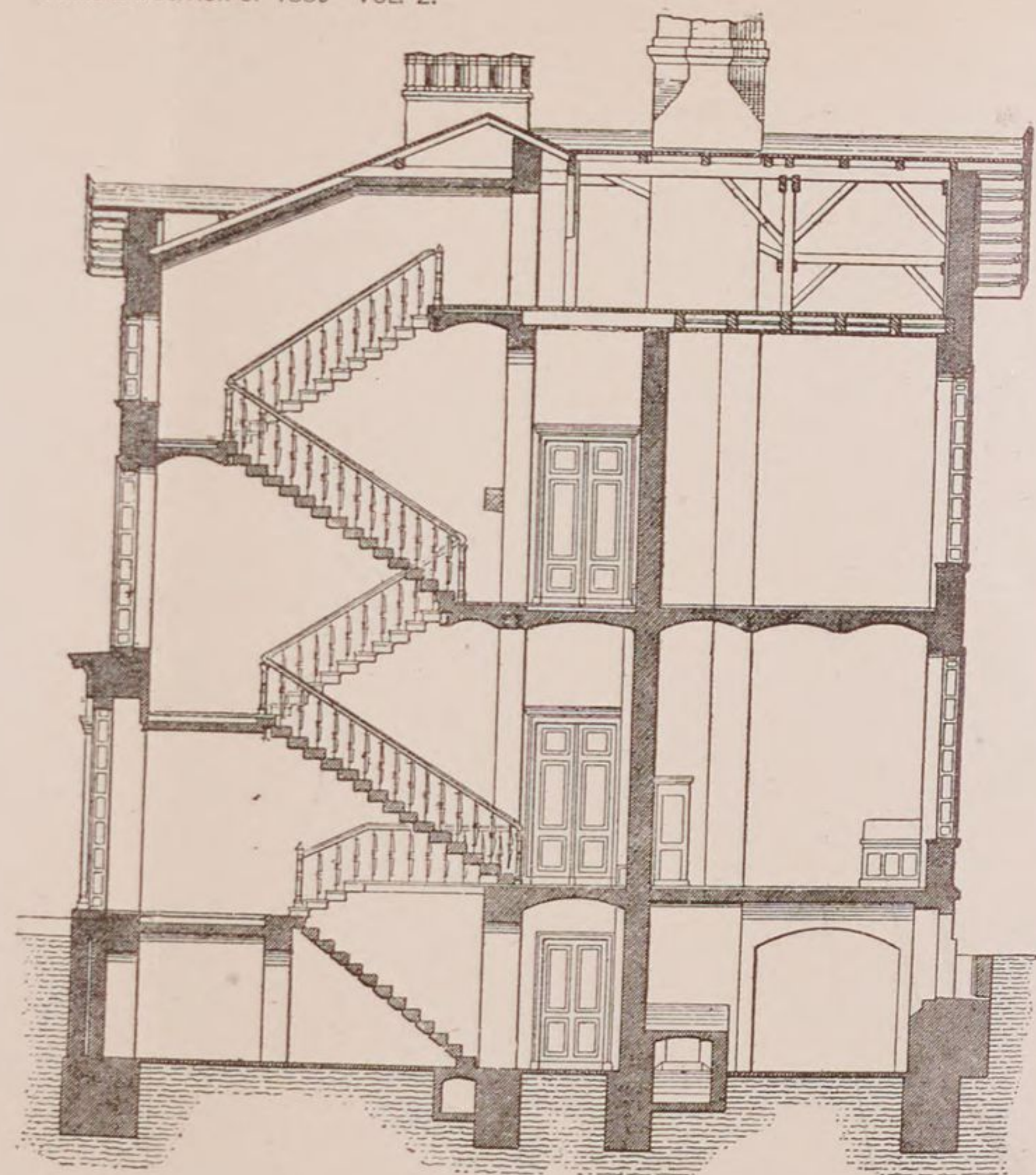
GENERAL CITY HOSPITAL, BERLIN—TWO-STORY PAVILION FOR 64 BEDS.



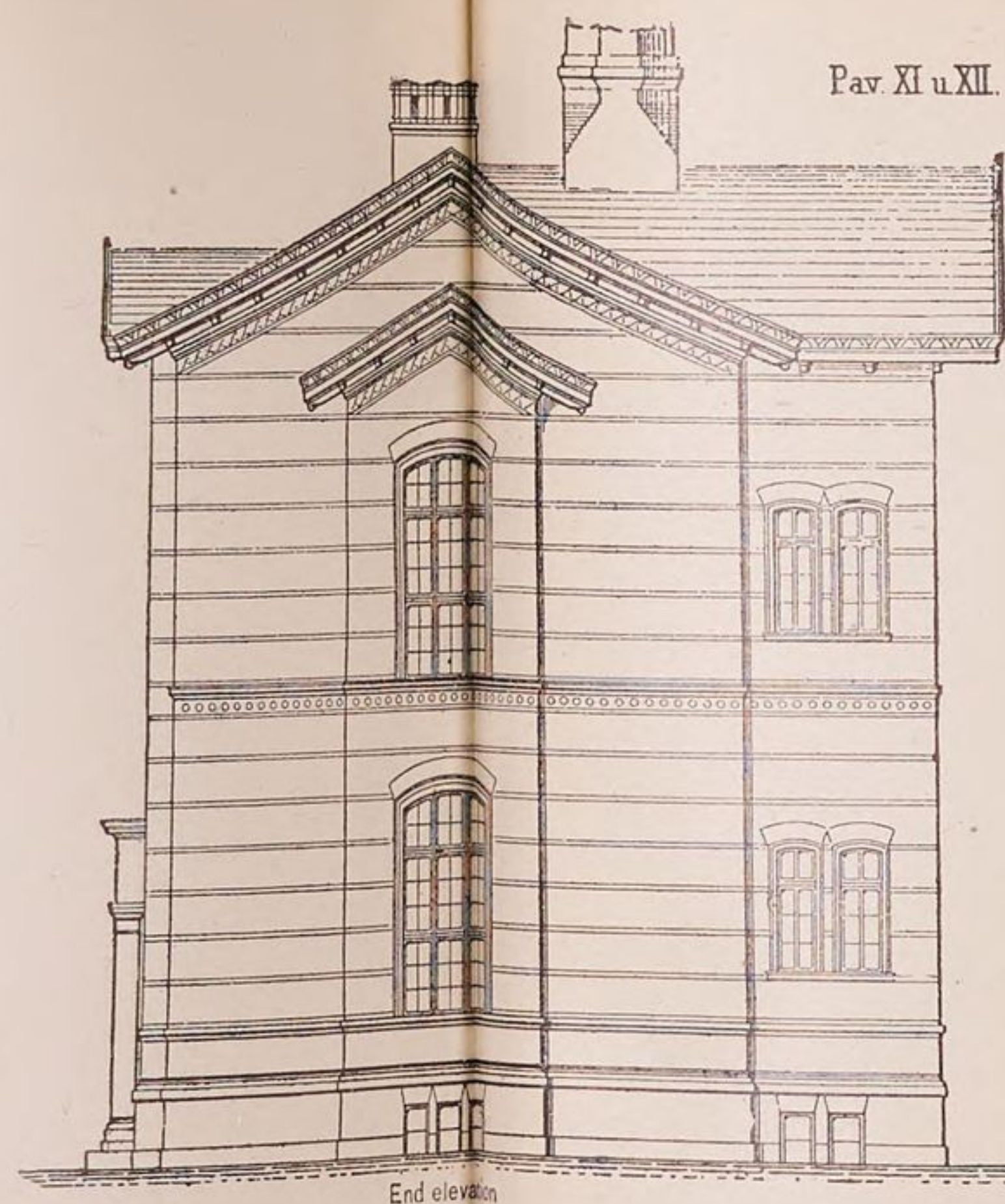
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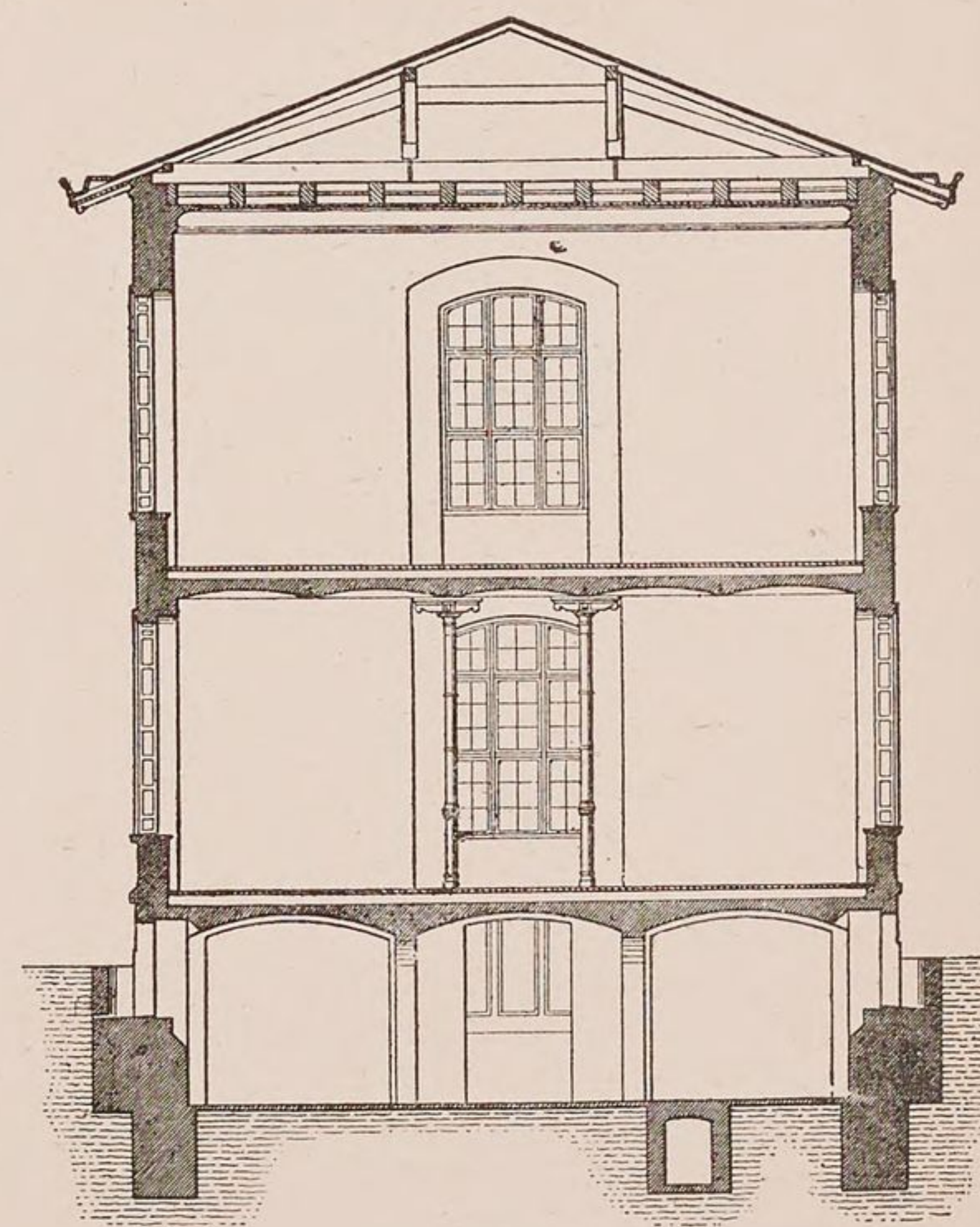
MUSEUM



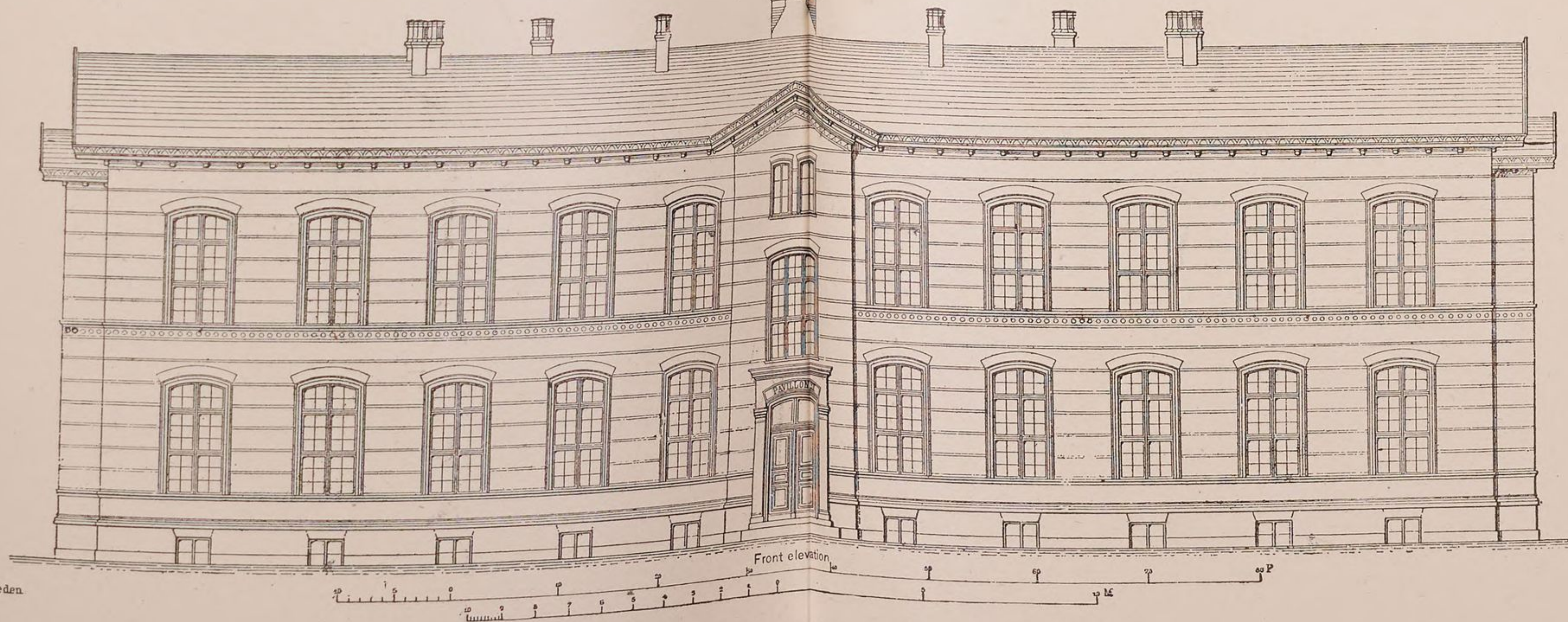
Section cd



End elevation



Section ef



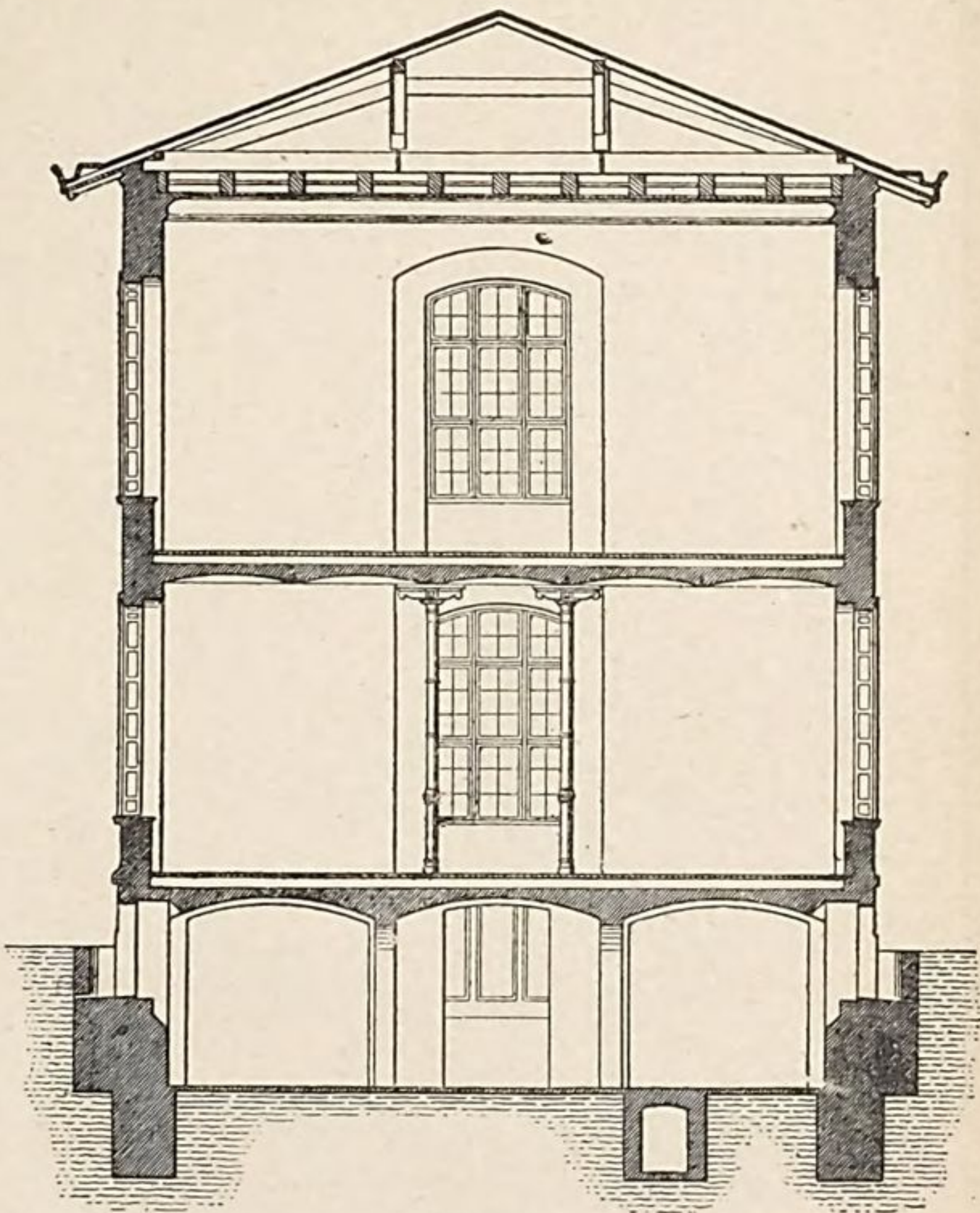
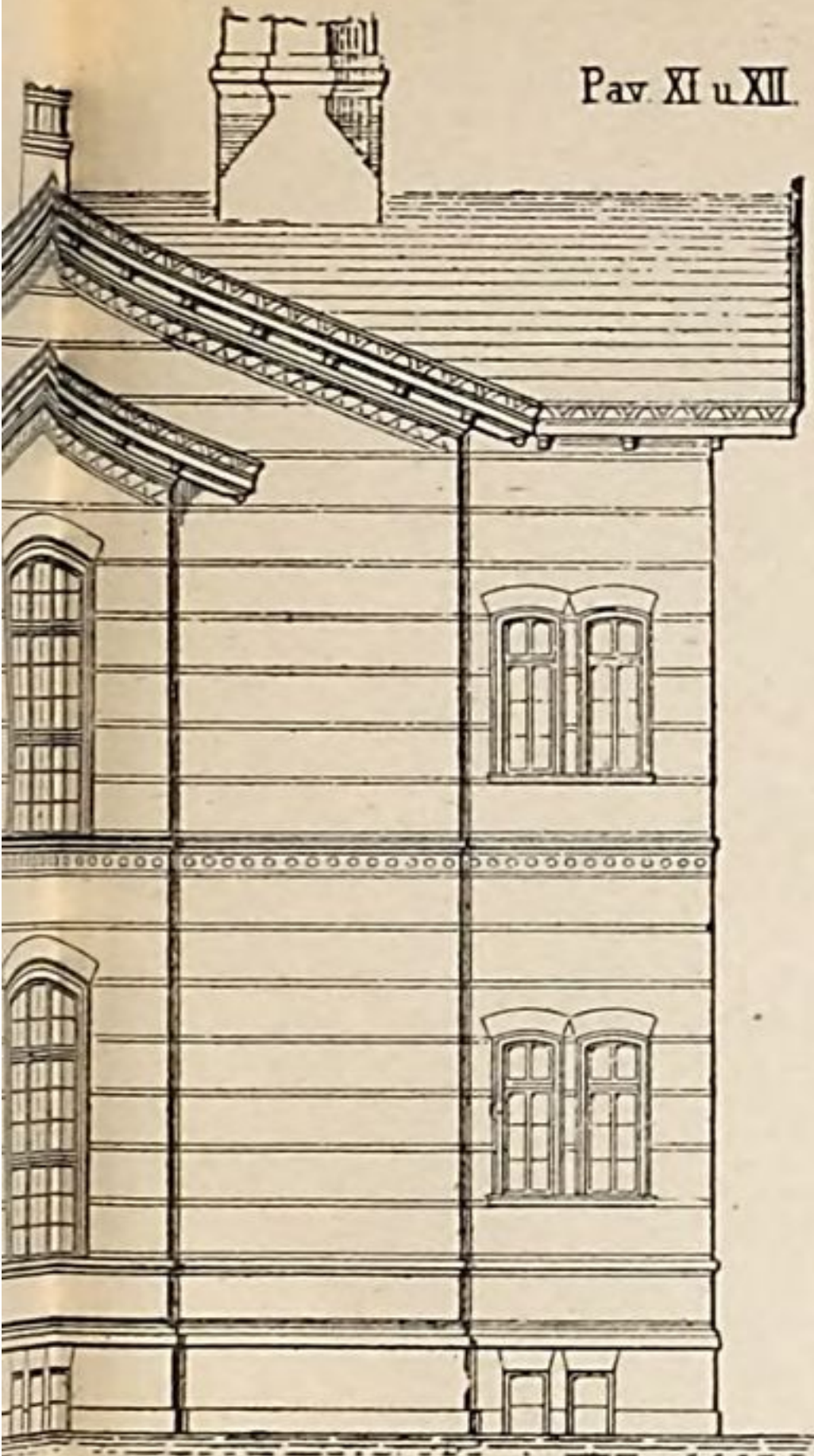
Front elevation

Entw. Gropius & Schmieden

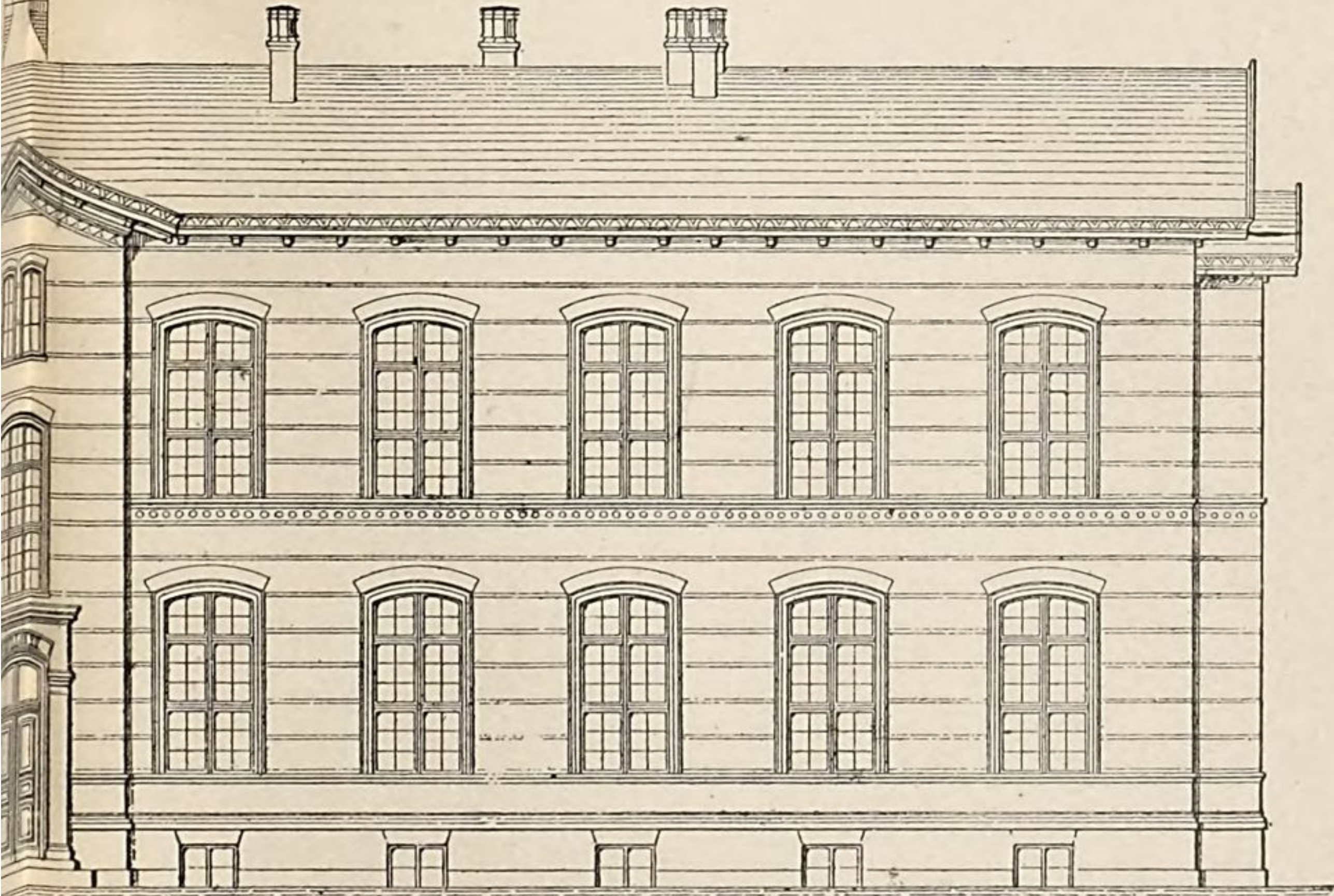
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GENERAL CITY HOSPITAL, BERLIN—ISOLATION PAVILION, 44 BEDS.

Pav. XI u XII.

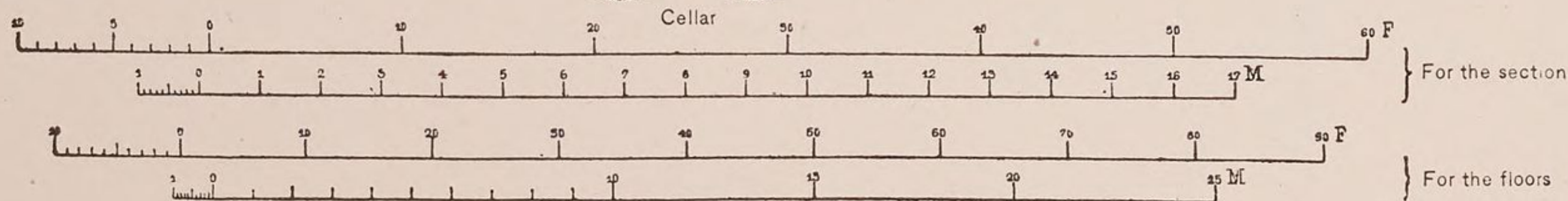
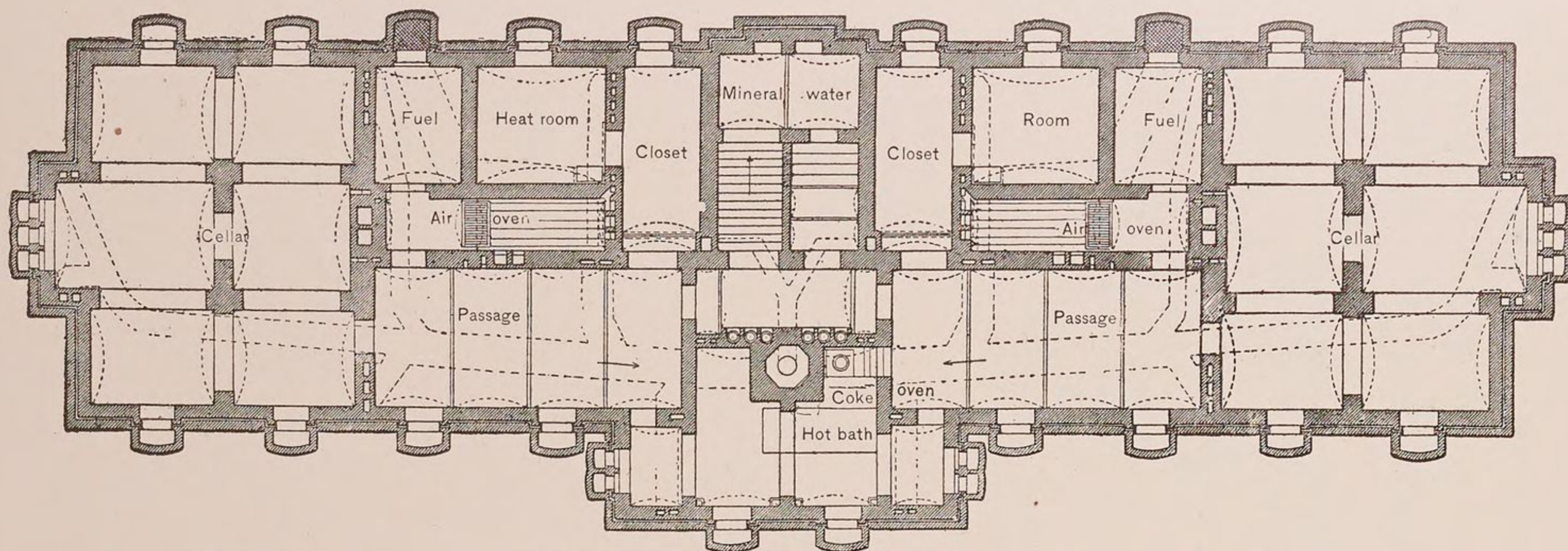
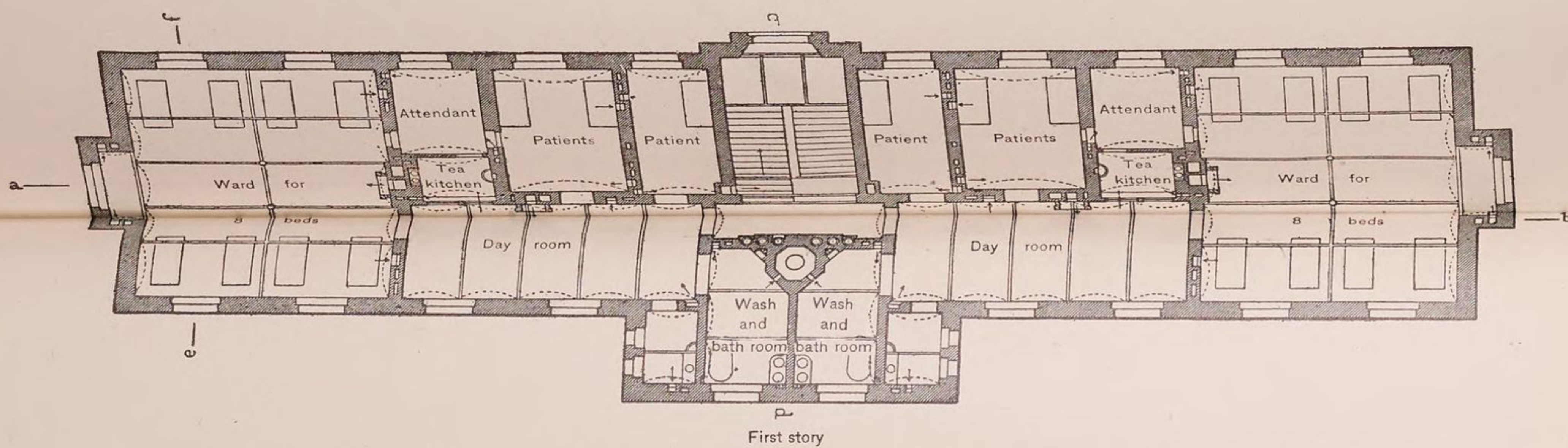
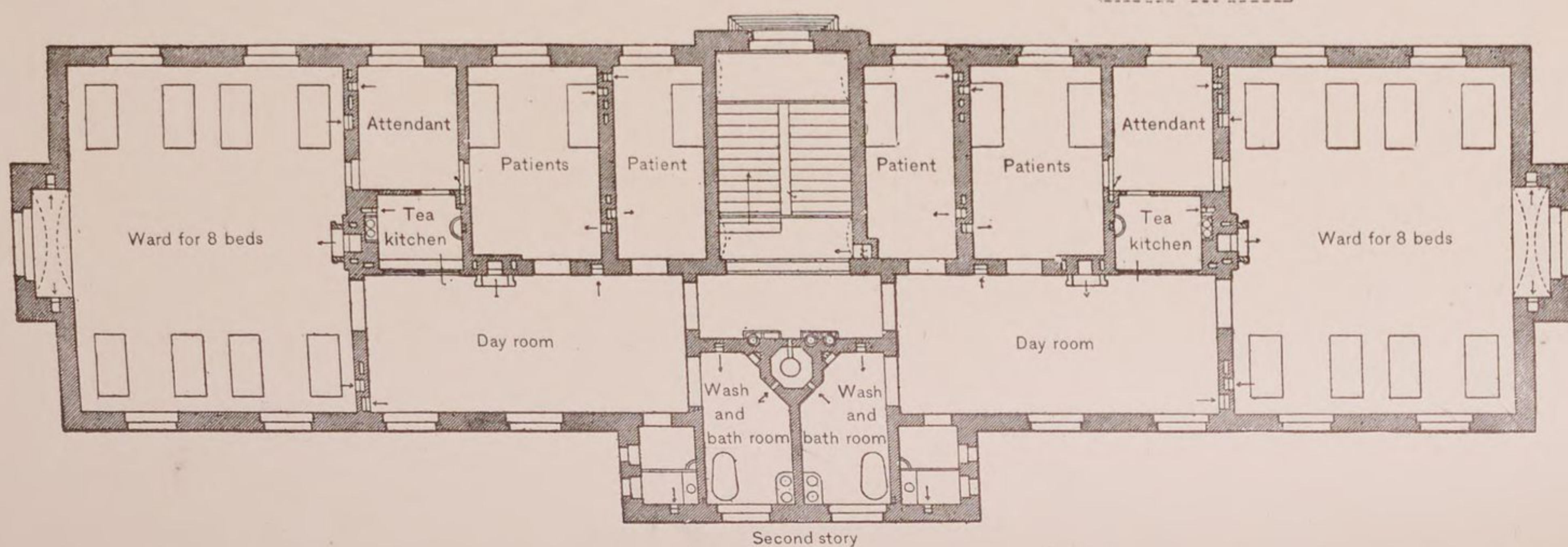
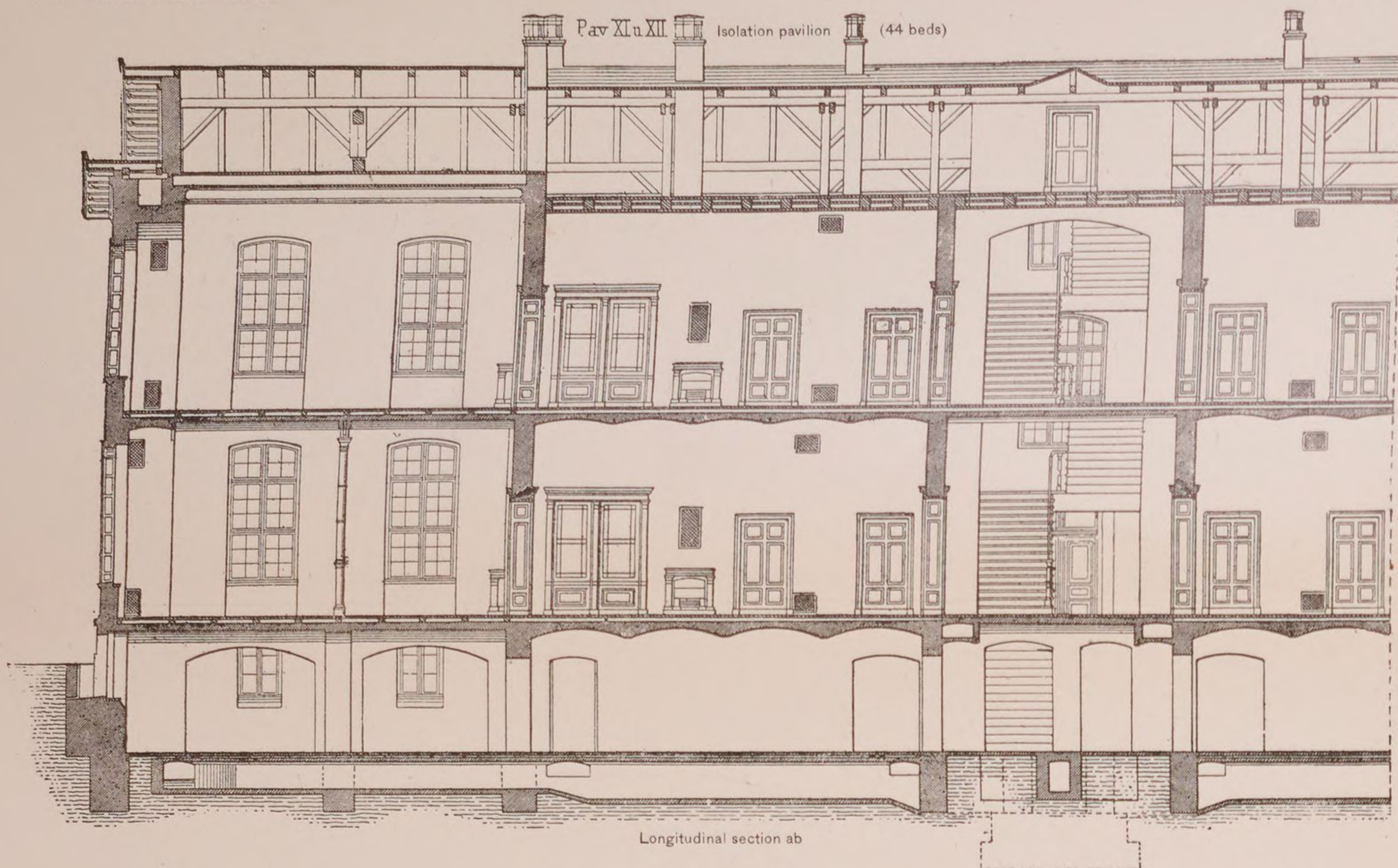


Section ef



Walther geat

ISOLATION PAVILION, 44 BEDS.



Ernst & Korn. Berlin

Ernst & Korn. Berlin

GENERAL CITY HOSPITAL, BERLIN—ISOLATION PAVILION, 44 BEDS.

THE JOHNS HOPKINS HOSPITAL, BALTIMORE, MARYLAND.

DESCRIPTION BY HENRY M. HURD, M. D.,

Superintendent of the Johns Hopkins Hospital.

[With 16 plates.]

In 1873 Johns Hopkins, a retired merchant of Baltimore, placed in the hands of trustees a large sum of money for the erection of a hospital. In a subsequent letter he gave specific directions as to its location and general arrangement. Upon his death the trustees, after consultation with many eminent hospital men in this country and Europe, selected Dr. John S. Billings, surgeon of the United States Army, to act as their medical adviser in the perfection of plans and the erection of the buildings. The work upon the grounds was commenced in 1875, and the buildings were finally completed in 1889. The wards were formally opened for the admission of patients in May, 1889.

The grounds upon which the hospital is built are located in East Baltimore, between Broadway and Wolfe streets on the west and east, and between Monument and Jefferson streets on the north and south, and include an area of about 14 acres, measuring about 856 feet from east to west, and 708 feet from north to south. The grounds are on the side of a hill, near its summit, sloping toward the southwest, the lowest point being at the southwest corner, 87 feet 6½ inches above mean tide; and the highest at the northeast corner 115 feet 6 inches above mean tide. The subsoil is clay with layers of sand for a depth of 20 feet with sand pockets at irregular intervals.

The west front of the buildings is shown in Plate CXIX, where a view is given of the administration building and the two pay wards. In Plate CXX a rear view of the hospital is given. Here, in order from the left, are the nurses' home, the female pay ward, the administration building, the male pay ward, the octagon ward, three common wards, and the isolating ward for contagious diseases. All the buildings mentioned are connected by a covered corridor, in the basement of which the hot and cold water, steam, soil, and drainage pipes are carried in what has been termed the "pipe-tunnel." Upon the first floor a covered corridor extends as a passageway from the different wards. Upon the top of this corridor an open terrace walk, on a level with the ward floors, at a uniform level of 124 feet above mean tide, is provided. In addition to the buildings shown in the rear view, there are shown upon the block plan (Plate CXXI) a bath house, kitchen building, clinical amphitheater, dispensary, stable, pathological laboratory, and autopsy building, and laundry.

The capacity of the hospital is two hundred and thirty-eight beds.

When completed according to the original plan, it will contain four hundred beds. The total cost of the buildings was \$1,610,405.03.

CONSTRUCTION.

The buildings are constructed of brick with trimmings of sandstone and of molded terra cotta. The foundations of the principal buildings consist of a solid concrete base ; of the other buildings broad flags of granite. All foundation and interior walls are of hard brick laid in Cumberland cement below the ground level, at which point they are covered by a layer of heavy slate. Lines of drain tile are laid around the foundations, and for all the buildings having cellars or half basements, the outer surface of the walls beneath the ground is sheathed with overlapping slates. Above the horizontal layers of slate at grade the walls are hollow with a 2-inch air space 9 inches from the inner surface. All pitched roofs are covered with carefully selected slate, laid on English asphalt felt, and secured with copper nails. The comparatively flat portions of the roofs are covered with copper, which is also used for all gutters, flashings, and down spouts. The floors of the principal buildings and of the corridor are formed of molded hollow blocks of hydraulic lime of Teil laid upon iron beams of suitable size and covered with wood, concrete, or asphalt. The floors of the basements are of artificial stone laid in large blocks, and underneath all heat coils is placed a heavy coat of asphalt to prevent the passage of ground air up through the heating coils. The floors of the pipe tunnel and kitchen are of concrete. The floors of the corridor and of the bath house are composed of cement and ground granite laid in blocks of suitable size, which form a very hard, smooth, and durable covering, easily cleaned. The floors of the bath rooms, water-closets, and lavatories are of asphalt. The floors of the main kitchen, and of all tea kitchens, are of concrete. The floors of all wards and rooms for the sick are of edge grain Georgia pine, $1\frac{1}{2}$ inches thick. All walls are plastered in three coats, and for the most part finished with a hard troweled sand finish. The stairways in the wards are of iron with a layer of asphalt in the treads. In all wards and rooms occupied by the sick woodwork is very sparingly used. Window sills are of slate. The woodwork is of ash, with plain beveled and rounded moldings, which may easily be cleaned with a damp cloth. The windows are finished with plain half-round heads and moldings. The wards are supplied with outside shutters so constructed that they can be opened above and below in the ordinary manner, or the lower half of the shutter can be turned outward to form a sort of awning, promoting free admission of air, and excluding light. The roofs are high pitched, giving an ample space above the ceilings, which space is ventilated so that the heat of the sun upon the slate roofs during the hot season does not affect

the wards. The walls of the wards are painted in oil of a French gray color. All hard wood is finished in hard oil.

HEATING AND VENTILATING.

The general heating plans, with sections, are given upon Plate CXXII. All the wards are heated mainly by a system of circulation through iron pipes of hot water of comparatively low temperature and pressure, the heat being furnished by boilers in the basement of the kitchen and nurses' home. In many of the rooms fire places are also provided. The hot water boilers for heating are six in number. Each boiler is 5 feet in diameter and 16 feet long. From the boilers the heated water passes into the great outflow main, which is a cast-iron pipe 26 inches inside diameter, hung on rollers from the ceiling of the pipe tunnel and provided with expansion joints, to guard against a breakage of the pipe from expansion and contraction. From this main flow pipe, pipes are given off at each building, and from these smaller mains the pipes in the heating coils are supplied. From these heating coils the cooled water returns by a similar system of pipes and mains to the boilers. The circuit is practically a closed one, none of the water being drawn off or used at any point, so that there is very little loss. The force which produces this circulation is a small one, being the difference between the weight of a column of heated water and that of a similar column of water at a temperature from 8° to 15° F. lower, each column being about 29 feet high, this being the difference in level between the water in the boilers and that of the top of the heating coils. By means of valves on all mains, and on the supply and discharge pipe to each coil, the rapidity of the circulation can be controlled for each building and each coil, thus giving a corresponding control over the temperature of the coils themselves, since this is dependent on the amount of water of a given temperature which passes through the coil in a given time. The entire system of hot water heating contains about 175,000 gallons of water, and practical trial has shown that it produces an equable, agreeable temperature in all the buildings to which it is applied, in all conditions of cold weather and with the fullest ventilation desired. To prevent loss and waste of heat from the mains in the pipe tunnel, and in the basements of the several buildings, these pipes are covered with felt enveloped in asbestos paper, and the whole is inclosed with stout canvas thoroughly painted. The effect of this protection is marked and satisfactory, very little heat is lost, as is shown by the low temperature in the pipe tunnel and a great saving of fuel is thus effected. The heating coil most distant from the kitchen boilers is that in the southeast end of the isolating ward, being 763 feet away, as measured along the tunnel and basement of the ward. With a temperature of 92.6° F. in the flow pipe, and 85.4° F. in the return, the rate of flow of water in this

apparatus is 13.5 feet per minute. With a temperature of 134.8° F. in the flow pipe, and 129.7° F. in the return, the velocity of the water is 16 feet per minute.

In the wards the flues, registers, and heating surfaces have been arranged to supply 1 cubic foot of fresh air per second for each person in the ward, with the possibility of doubling this supply for a short time should it become necessary to flush the ward with fresh air. In the isolating ward, designed for cases giving rise to offensive odors, or in which a large amount of organic matter is thrown off, the air supply is fixed at 2 cubic feet per second per person. Three rooms in the isolating ward are arranged with perforated floors to supply 4 cubic feet of air per second per person, with the ability to double it, if desired. All the air in cold weather is warmed before it is admitted to the wards. The fresh-air registers are placed in the piers in the outer walls at a height of 9 inches from the floor, one register being allowed to each pair of beds. Besides these there are registers beneath the windows in the wards, which are used in cold weather to check the down drafts produced by the chilling of the air from contact with the glass of the windows. The chief register in the pier between each pair of beds is so arranged that the nurse, by turning the iron arm upon its face, can reduce the temperature of the incoming air nearly to that of the external air, or can increase it to the maximum which the heating coil affords, but without changing the quantity of the air admitted. In other words, the supply of fresh air can not be shut off whenever it becomes necessary to reduce the temperature of a ward.

SEWAGE DISPOSAL AND DRAINAGE.

The foul water from the various buildings, the water-closet, and ward sink sewerage are kept distinct from the water discharged from the kitchen sinks, wash basins, etc. All pipes, whether soil or drainage, are placed so as to be readily accessible and fully exposed to view. All fixtures have separate traps placed as close to the fixture as possible. All traps have back ventilation, and all perpendicular soil pipes extend upward through the roof full size and open freely to the outer air. The water-closets are washout closets. The bath tubs are of iron, not inclosed with woodwork, and are movable from place to place, being unconnected with the plumbing. The sinks are of porcelain. Those for the use of the ward nurses and housemaids have an all-around flushing rim, as well as a central flush. All pipes and traps are either fully exposed to view or are readily accessible by opening a door. In all the wards the perpendicular soil and trap vent pipes are placed in a large ventilating shaft, which extends above the roof and has in it an accelerating steam coil to secure a constant upward current. Into this shaft pass ventilating pipes from the water-closets and urinals.

THE OCTAGON WARD.

This ward differs from the others in having two stories, besides the usual basement for heating apparatus. The exterior view of it is shown in Plate CXXIII, an interior view in Plate CXXIV. The diameter of this ward is 57 feet 8 inches; the length of each face on the inner surface is 23 feet 10 inches. The height at the center against the central chimney is 16 feet, the height at the walls is 15 feet. The average wall area per bed is 120 square feet. The number of square feet of floor area per bed is 114.9, and the number of square feet per bed is 1,760.8. The cubic capacity of the whole ward, including the bay window, is 42,160.8 feet.

The heating of the ward is effected by hot water coming from the mains in the pipe tunnel, and passing through coils of 3-inch cast-iron pipe, arranged in stacks in the basement against the outer walls. Under ordinary circumstances in cold weather the average temperature in these coils is 150° F., but this temperature may be lowered by lessening the velocity of the current of water passing through the pipes. The fresh air supply is admitted through openings in the exterior walls of the basement of the ward, coming from over the green lawn surrounding it. This opening in the wall is protected by wire netting, and communicates with a galvanized iron flue which passes downward to open in the chamber beneath the heating coil, and also upward directly to the fresh-air register in the ward. In this flue opposite the external opening is a cast-iron valve or damper, operated from the ward above, by means of which the incoming air can be either directed wholly downward so that it must all pass through the heating coil, or wholly upward so that it passes directly to the ward without being heated, or partly upward and partly downward so as to produce a mixture of any desired temperature. The heating coils are inclosed in brick chambers which have at the top in front of the coils a large plate composed of two sheets of galvanized iron with felt between. These plates or doors fit tightly, but can be readily removed to give access to the pipes for the purpose of cleansing or repair.

Ventilation.—Rising through the center of the ward is an octagonal brick chimney 8 feet in diameter internally, and with walls 2 feet 6 inches thick, making a total external diameter of 13 feet. Upon each face of this chimney are two openings from the ward, one near the floor the other near the ceiling, each measuring 20 by 26 inches. Those in the lower ward open directly into the central shaft. Within this brick chimney is set a boiler-iron tube 5 feet 9 inches in diameter, rising on a projecting cast-iron base built into the walls, which tube extends from the floor of the lower ward to above the ceiling of the upper one. Into the space between this boiler-iron flue and the outer chimney the openings from the upper ward enter. Just above the

top of the boiler-iron flue is placed an accelerating coil of steam pipe. Through the center of the chimney rises a cast-iron pipe 12 inches in diameter, which serves as a smoke flue for the open fire places to be placed in the wards against the central chimney, should they be found necessary.

In the wards the general direction of the air currents is from the circumference toward the central shaft. In cold weather the air passes either entirely or in part through the heating coils, and is allowed to escape through openings near the floor in the central shaft in order to secure a uniform diffusion of fresh air and to diminish the loss of heat. During the warm weather or when it is desired to rapidly change the air of the ward the upper registers in the central shaft near the ceiling are opened in addition to the lower ones.

Next to the ward at the north end are the nurses' closet, the bath-room, lavatory, and water-closets, while on the other side of the corridor are the tea kitchen, the dining room, two wards for one or two beds each, and the clothing and linen closets. The nurse has neither sleeping nor sitting room, but resides in the adjacent nurses' home. The tea kitchen is provided with a small gas range and a steam table. In the nurse's closet is a drying closet heated by steam. The bath tub is movable and can be raised on a truck and carried to any bedside, if desired.

The ground plan of the octagon ward is given in Plate CXXV. A longitudinal section of the building from north to south is given in Fig. 1, Plate CXXVI, a cross section from east to west is given in Fig. 2, Plate CXXVI.

THE COMMON WARD.

The longitudinal pavilions, known as the common wards, are three in number. The exterior view from the southeast is given in Plate CXXVII. An interior view is given in Plate CXXVIII. The main floor plans and sections showing ventilation and arrangement of rooms, are shown upon Plate CXXIX. The basement and attic floor plans are given upon Plate CXXX. The longitudinal section from north to south is given upon Plate CXXXI. The axes of all the wards run directly north and south so that the windows generally face east and west. The least distance between any two pavilions is 60 feet.

The main ward is a room 99 feet 6 inches long, 27 feet 6 inches wide, 15 feet high at the side walls, and 16 feet high in the clear in the center. It is intended to contain twenty-four beds. Each bed has a wall space of 7 feet 6 inches, a floor area of 106.9 square feet, and a cubic air space of 1,768.9 feet. At the south end of the ward is a large bay window, which forms a sun room. Right angles in the ward are avoided as far as possible; all corners are rounded. The junction of the ceiling with the walls forms a quarter circle, and also the junc-

tion of the walls with the floor. The method of heating is similar to that described in the octagon ward

Ventilation.—Two systems of exhaust flues are provided to remove foul air from the ward. The first consists of a series of circular openings in the floor of the ward, one beneath the foot of each bed. These openings are 12 inches in diameter, and are each covered with a nearly hemispherical dome of wire netting to prevent the accumulation of rubbish in the flues beneath. Each opening communicates with a galvanized iron tube, 12 inches in diameter, which passes obliquely on the ceiling of the basement to enter the lower foul air duct, which runs longitudinally beneath the ward floor and enters the ventilating chimney. The main longitudinal foul air duct is constructed of wood, lined with galvanized iron. At the end most remote from the chimney it measures internally 1 foot 10 inches by 1 foot 3 inches, and from this point it gradually enlarges to provide for the additional flues which enter it until at the point where it enters the ventilating chimney it measures 4 feet 4 inches by 2 feet 10 inches. The ventilating chimney is 4 feet 2 inches in diameter and 75 feet high. The principal system for the escape of foul air consists of six openings in the center of the ceiling of the ward, each measuring 2 feet by 2 feet and placed 13 feet apart. These open into the upper foul air duct running longitudinally in the attic above the ceiling of the ward to the ventilating chimney and corresponding to the lower duct. The ceiling of the ward is 1 foot higher in the center than at the sides. The openings in the ceiling leading into the upper foul air duct are controlled by shutters, which can be raised or lowered by moving an iron lever in the ventilating chimney. In the main ventilating chimney or aspirating shaft, a coil of steam pipe, heated by high pressure steam, is placed to increase the velocity of the upward current of air in the chimney. Under ordinary circumstances the downward ventilation alone is used. Whenever the ward becomes heated, however, or it is desired to pass a large quantity of air through it, the ceiling registers are opened. In moderate and warm weather both sets of registers are opened. In addition to these methods of producing air currents a propelling fan is placed in the basement at the south end. This fan, which is propelled by steam-power, is 4 feet in diameter. It is placed in the mouth of a duct communicating with each coil chamber at the floor. By means of this fan a very large amount of fresh air can be forced into the ward to secure a thorough flushing and the removal of unpleasant odors. The whole system of ventilation is designed to secure 1 cubic foot of fresh air per second for each of the twenty-four beds in the room. This amount can be doubled, should it become desirable to do so.

THE ISOLATING WARD.

This ward is situated at the extreme end of the north corridor, as shown upon the block plan, Plate CXXI. An exterior view from the northeast is shown upon Plate CXXXII. A longitudinal section from north to south and details are shown upon Plate CXXXIII.

The essential feature of this pavilion is that the central corridor is freely open to the external air at either end, and rises through the building in a clerestory at the top, the sides of the clerestory being fitted with movable glass louvers.

The walls of this corridor are practically double, and it is necessary to pass through a vestibule with two sets of doors to enter a patient's room. Each room measures 11 feet by 13 feet 1 inch. It has an open fire-place with a separate chimney flue placed in the center of the inner wall of the room. At one side of this chimney and fireplace is an entrance to the room from the corridor, through the vestibule mentioned above. On the other side of the chimney is a small closet to contain a commode, access to which is gained from the outside through an opening in the wall. This closet is lined with galvanized iron and has a separate exit flue, provided with an accelerating steam coil. The door of the closet is arranged for free access of air, and the exit of foul air from the room takes place mainly through the special flue of this closet. The whole of the closet and its exit flue can be readily cleansed with flame. This arrangement is made so that every patient taken to this ward can be isolated not only from the rest of the hospital, but also from all other patients in the ward. There is no common water-closet or bathroom, and no possibility of the passage of air from one room to another by means of the common corridor, because this is practically an open-air passage. Fresh air enters these rooms through registers in the outer wall, the arrangements for heating and regulating the temperature of the incoming air being substantially the same as those described for the common ward pavilion. The amount of heating surface, however, is greater, being calculated for a constant supply of 2 cubic feet per second per person. The chamber utensils containing excreta when removed from the commodes are taken to a sink inclosed by glass doors with special ventilation and air supply, so that the excreta can be thoroughly disinfected and disposed of.

Three of the rooms marked I on the plan shown in Fig. 1, Plate CXXXIV, are larger than the others, and in these rooms the fresh incoming air, instead of entering through a register in the side walls, enters through the floor which, for a distance of 7 feet from the outer wall, is perforated with one-fourth inch holes, giving more than 94 square feet of floor with fifty holes to the square foot. These holes

are slightly funnel shaped, and twenty of them are estimated to be equal to 1 square inch of inlet. The object is to supply a large amount of air, about 4 cubic feet per second to each inmate, and to have this air pass constantly upward so that no portion of it shall be rebreathed or come a second time in contact with the patient, thus placing him in the condition of being out of doors in a gentle current of air.

In order to secure as little communication as possible between this ward and the rest of the hospital, arrangements are provided that the nurses on duty in this building shall remain for considerable periods of time, and accordingly two bedrooms are provided for nurses, each room to contain two beds. The bath tub in this building is provided with a truck which can be readily wheeled into any room.

THE ADMINISTRATION BUILDING.

The administration building contains three floors besides the cellar, and finished attic story, and is crowned with a dome and spire in the center. It also has an annex in the rear which contains water-closets and bathrooms. The cellar or half basement is 14 feet in the clear, is floored with concrete, and contains the hot water coils for heating the building. The main or first floor contains a large rotunda opening through the entire building to the central dome, the offices, library, reception, examination, and board rooms. The second floor is devoted to the living rooms of the superintendent and resident physicians, and the third floor is intended for bedrooms for the resident students. All water and soil pipes are confined to the rear annex building, on the upper floor of which are three boiler-iron water tanks, which hold 31,843 gallons of water.

Immediately in the rear of the administration building, separated from it by a covered corridor, is the apothecary's building so called, which contains a pharmacy, with waiting room and bedrooms for the apothecary and his assistant; also a large general dining room for the officers of the hospital. The second and third stories contain rooms for female employés, with bathrooms and water-closets. The cellar of the building contains rooms for the storage of drugs, and a room with a furnace, smoke chimney, and ventilating chimney, for the manufacture of pharmaceutical products.

THE PAY WARDS.

The pay wards are two in number, the north one being devoted to general medical and surgical cases, the south one to gynecological cases. Each ward is 130 feet long, $49\frac{1}{2}$ feet wide, and two stories high, with a cellar; also a rear projection in the center, containing bathrooms, water-closets, staircases, etc. Each floor contains a series of rooms situated upon each side of a central corridor, which

runs north and south, opening at either end upon a veranda. The rooms for patients are each 15 feet 5 inches long, and from 12 to 13 feet in width. Each has an open fireplace in the corner next the corridor. The fresh air is brought in through a register near the floor in the external wall. Besides the open fireplace and chimney flue each room has an exit flue 9 by 16 inches in the inner or corridor wall next the fireplace. These flues pass upward to the attic, where they are gathered into a single galvanized iron flue which passes to the center of the building, where it enters a perpendicular shaft in which is an accelerating steam coil. The buildings are finished in ash, and are plainly but comfortably furnished. Each bed has over it an iron crane or swinging bracket, from which is suspended a strong leather strap, so that a patient can assist himself to turn or rise in bed.

THE KITCHEN.

The kitchen building is 75 feet square and three stories in height. The main floor is on a level with the floor of the corridor, into which it opens on the south. It contains a kitchen, scullery, refrigerating rooms, storeroom, and employés' dining room. The second floor contains rooms for the housekeeper and cooks, the dining rooms for the servants and employés of the hospital. The basement floor contains a bakery, bread storeroom, training-school kitchen, and cold rooms. In the basement are boiler vaults, containing hot water and steam boilers, also water filters for the entire hospital. Immediately adjacent and under the sidewalk are vaults for the storage of fuel.

THE NURSES' HOME.

The nurses' home is a square building measuring 90 feet on each side, four stories in height above the cellar, with a central clere-story. The cellar of this building contains hot-water boilers, fuel vaults, and storerooms. The basement contains the nurses' dining room, the training kitchen, a large pantry, a lecture room, sewing rooms, and storerooms. The main floor, which is on a level with the corridor floor, contains a large main hall, the nurses' parlor, and library, apartments for the superintendent of nurses, rooms for the head nurses, etc. The two upper floors contain rooms for the pupil and night nurses. The building is in reality a square central tower surrounded by corridors on all sides with an external shell of living rooms. The central tower contains a large ventilating chimney, the stairway, water-closets, and bathrooms. In the outer shell each nurse has a room to herself. All water and soil pipes are in the central tower, and two large shafts for air and light are also carried up through it. The building is heated by hot water, radiating coils being in the cellar for all living rooms. The nurses' home is an entirely independent building.

AMPHITHEATER AND DISPENSARY

The amphitheater is a one-story building with a cellar, measuring 91 by 75 feet, and is connected with the hospital by an inclosed corridor. It contains a large amphitheater, measuring 52 by 47 feet, with a seating capacity for about two hundred and eighty persons, a special operating room, measuring 18 by 24 feet, well lighted from the south and by a large bay window on the east, an etherizing room, recovering room, a surgeon's room, a small special ward for three beds, and an accident reception room containing two beds. The heating of the amphitheater is effected by steam coils placed in the space below the seats, the fresh warm air entering through the risers. The foul air is drawn off into a ventilating chimney 6 feet square, which is in the center of the building. The amphitheater is lighted by a large skylight, and also by a window on the north side. Opening from the amphitheater is a dark room intended for use in developing negatives, which are taken by photography in the amphitheater itself. The special ward is intended for those cases which are not well enough to be taken back to the wards after an operation.

The dispensary, which is situated east of the amphitheater and connected with it by a covered corridor, is a brick building of one story, measuring 91 by 75 feet. It contains a large central waiting room 52 feet square, on the east and west sides of which are rooms for the physicians, surgeons, and specialists, who have charge of this service. It is heated by steam coils in the cellar, the fresh warm air being delivered through the risers and backs of the benches. The foul air is extracted by a large ventilating shaft on the south of the general waiting room, this shaft being 6 feet square internally. The foul air may enter this through a large opening near the floor level, or through a large duct communicating with the skylight. The general waiting room is lighted by a large central skylight, the other rooms by side windows. Medicines are dispensed from the pharmacy, which is on the south side of the waiting room.

THE PATHOLOGICAL BUILDING.

The pathological building is situated on the northeast corner of the hospital grounds, and is disconnected from all other buildings. It is a two-story building, measuring 58 by 78 feet. On the lower or ground floor is a morgue, a waiting room, an autopsy theater, a room for those engaged in private research, and rooms for bacteriological work. On the second floor is the director's laboratory, a laboratory for pathological histology, one for experimental pathology, a pathological museum, and a photograph room. The morgue measures 17 by 29 feet. It is not heated, and is ventilated so that no communication exists between the air of this and any other room in the build-

ing. The floor is of asphalt. The autopsy theater measures 29 by 38 feet, and extends through both stories of the building. It is lighted by a skylight, and by windows on the east. It is so arranged that observers can stand upon elevated tiers arranged semicircularly around the autopsy table. The floor is of asphalt. The room is ventilated by a ventilating shaft 3 feet by 3 feet 6 inches. There is also an arrangement for downward ventilation from the autopsy table through a tube opening in its center. The bacteriological rooms occupy the northern side of the building, and are fitted up with all the necessary apparatus. There are steam sterilizers, a cremation furnace inclosed in an iron hood, and hot air sterilizers. The floors of these rooms are of asphalt, and can be flushed with water. The basement contains the heating apparatus and a room for animal cages. These cages are especially constructed so that they can be readily taken apart and cleansed or sterilized.

THE LAUNDRY.

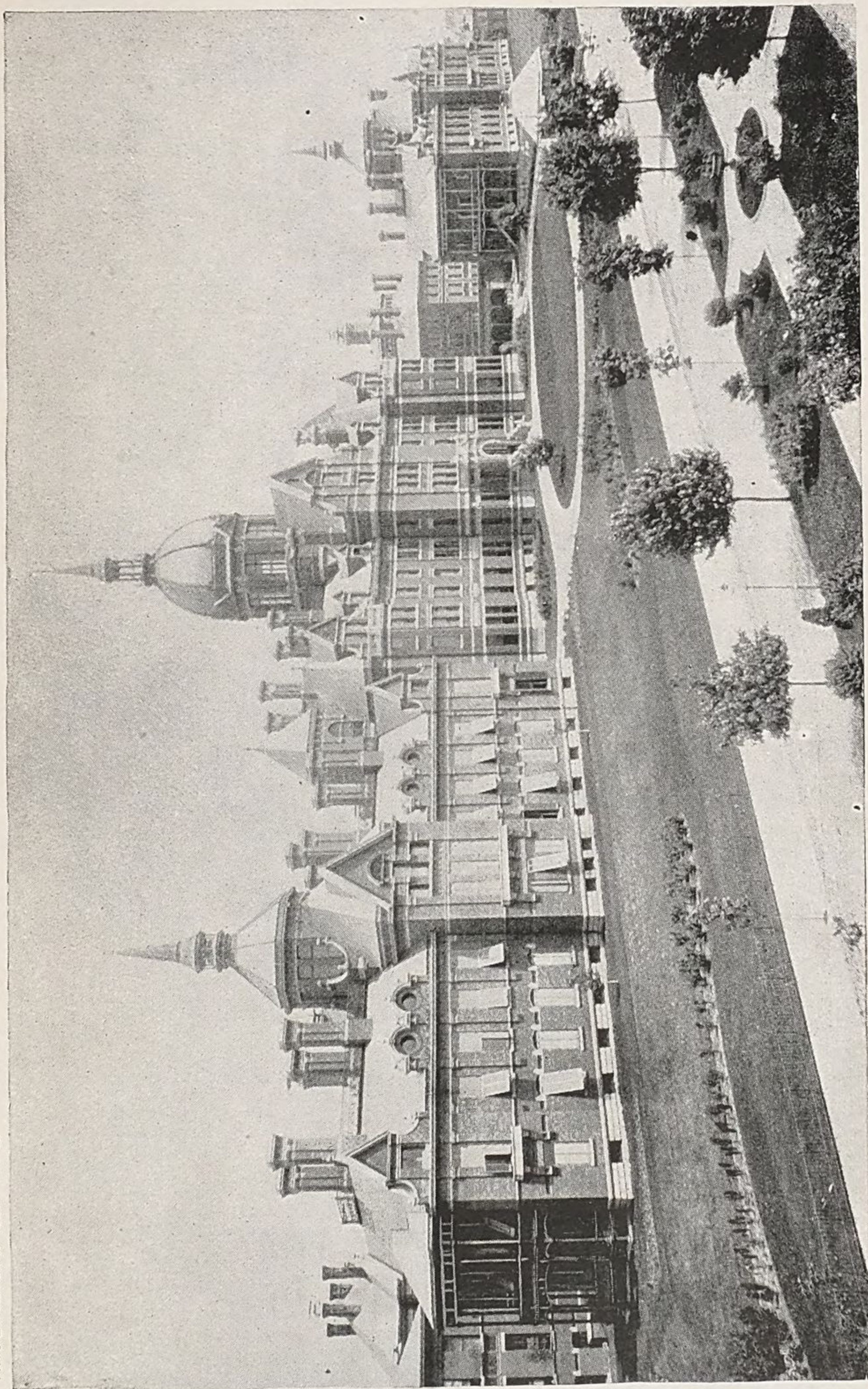
The laundry is situated on the southeast corner of the hospital grounds, at a point so far removed from the other buildings that no offense may arise from it. It is a brick building measuring externally 115 by 56 feet, and is one story high, with a basement and cellar. The basement contains the steam-boilers, storage vaults for coal, the steam-engine, and disinfecting chamber. The disinfecting chamber is made of boiler-iron, and has a double shell, into the space between which steam is forced. Live steam can also be admitted into the interior chamber. It is elliptical in shape, the longer diameter being perpendicular. The chamber is 7 feet 2 inches long, 7 feet 5 inches high, and 5 feet 4 inches wide. There is also a large iron kettle of a capacity of 90 gallons, double jacketed, heated by steam, in which articles of clothing or bedding can be steamed or boiled, should occasion require. The main floor of the laundry contains rooms for the washing and drying of the bedding and clothing from patients, and similar rooms for the laundry work of the officers and employés. The vapor from the washing machines is carried off through copper pipes 4 inches in diameter into a ventilating shaft. The top of the laundry has a flat roof, and is provided with lines for hanging clothing in the fresh air and sunshine whenever the weather will permit, the clothing being conveyed by a steam lift to and from the roof.

THE BATH HOUSE.

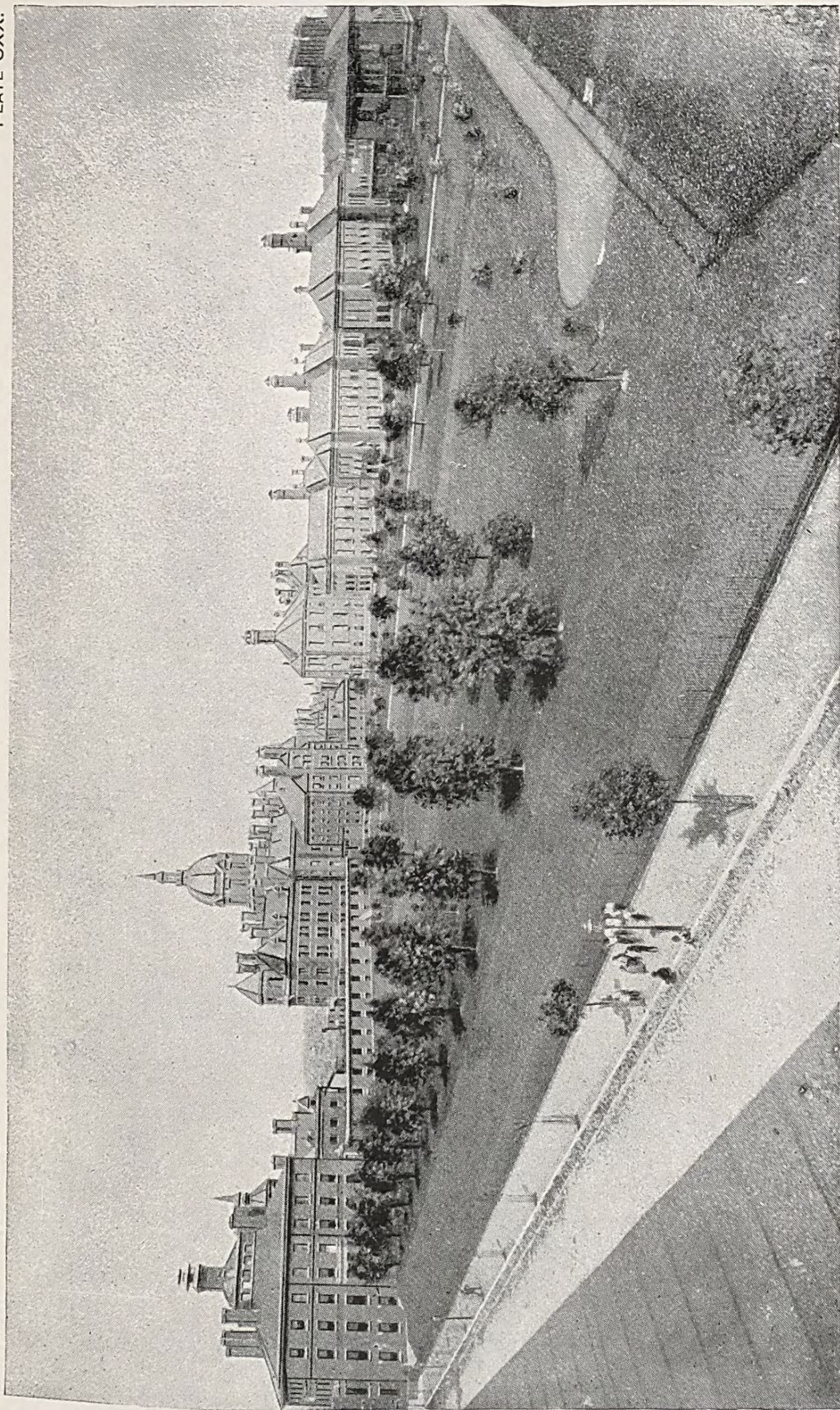
The bath house is situated in the southwest angle of the intersection of the main north and south corridor and the corridor leading to the male pay ward. It is a one-story building with a basement, and measures 64 by 31 feet, the long axis running north and south. It contains rooms for hot-air baths and for steam baths with dress-

ing rooms ; also rooms for mercurial and sulphur baths. The building is heated by steam and ventilated by a central chimney 4 feet square. The floors of the building are of granolithic pavement, and the walls have a soapstone finish.

A convalescent home, with a capacity of fifty beds, is a part of the original plan of the hospital. This home is to be situated in the suburbs of Baltimore, and is designed to relieve the hospital in the city of a class of patients who do not require the closest hospital attendance during the latter part of the period of convalescence.

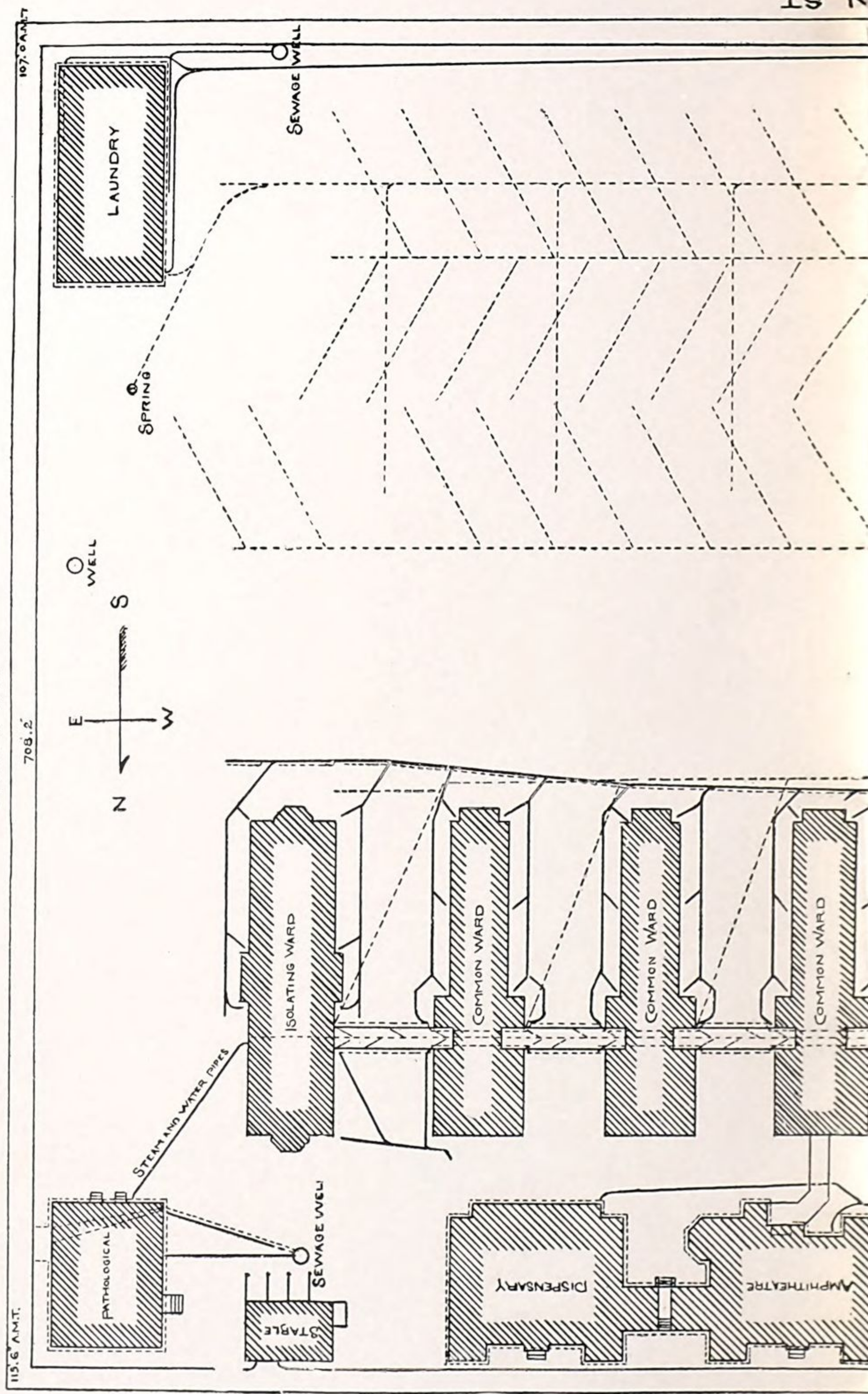


THE JOHNS HOPKINS HOSPITAL, BALTIMORE, MARYLAND—FRONT VIEW.



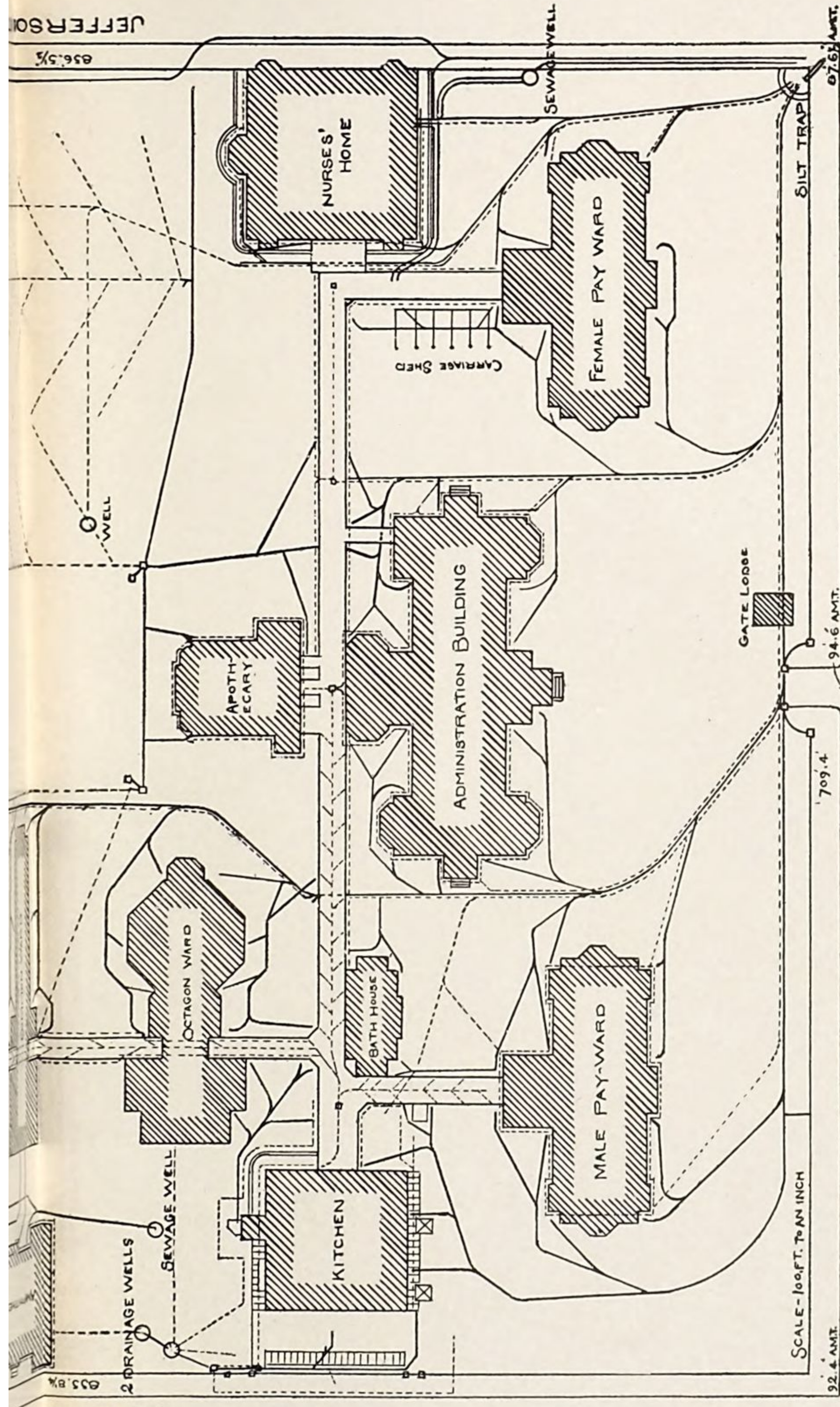
JOHNS HOPKINS HOSPITAL—REAR VIEW.

WOLFE ST.



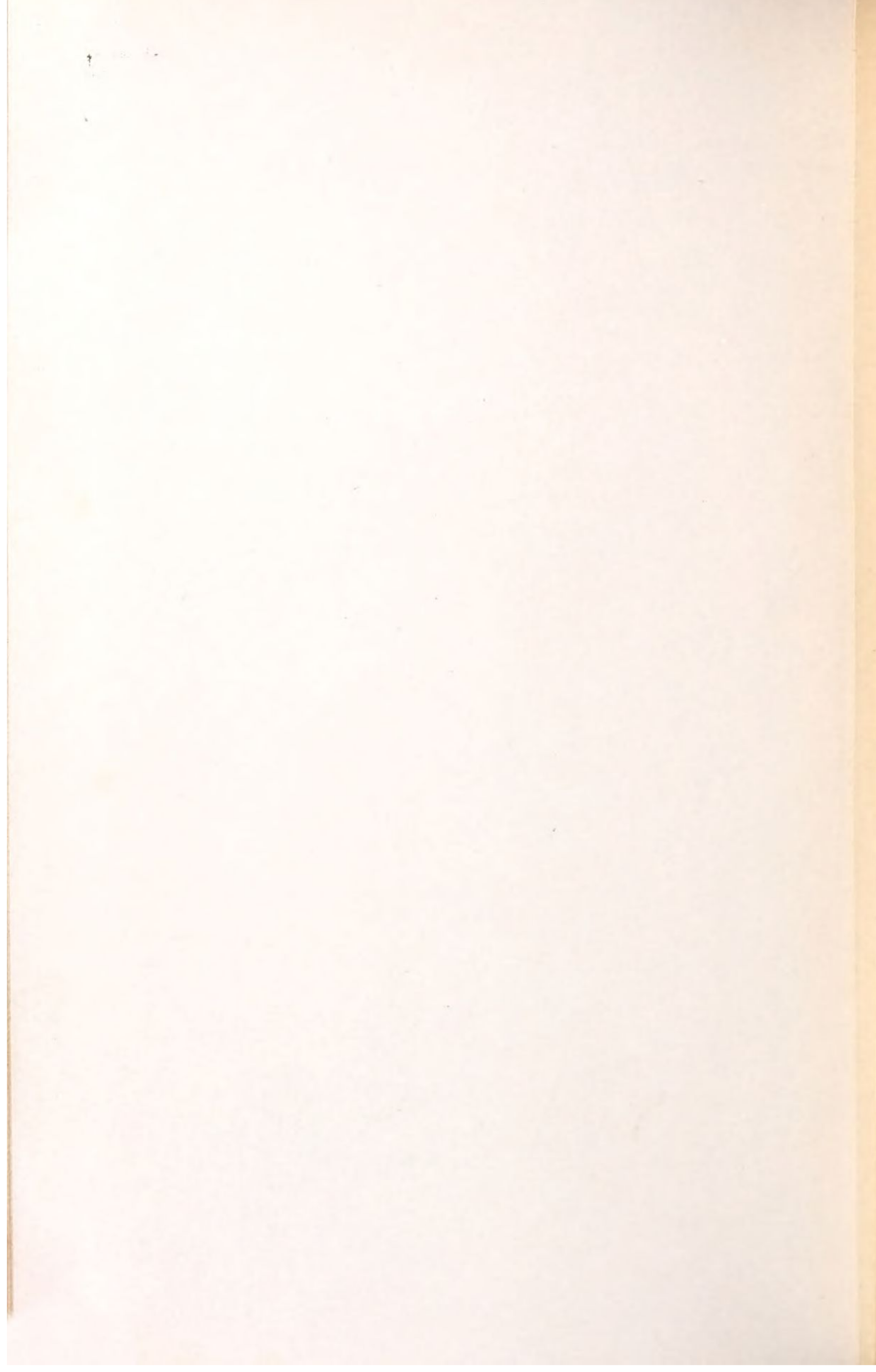
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BROADWAY

JOHNS HOPKINS HOSPITAL—BLOCK PLAN.



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PLATE CXXII.

GENERAL HEATING.

Plans and sections.

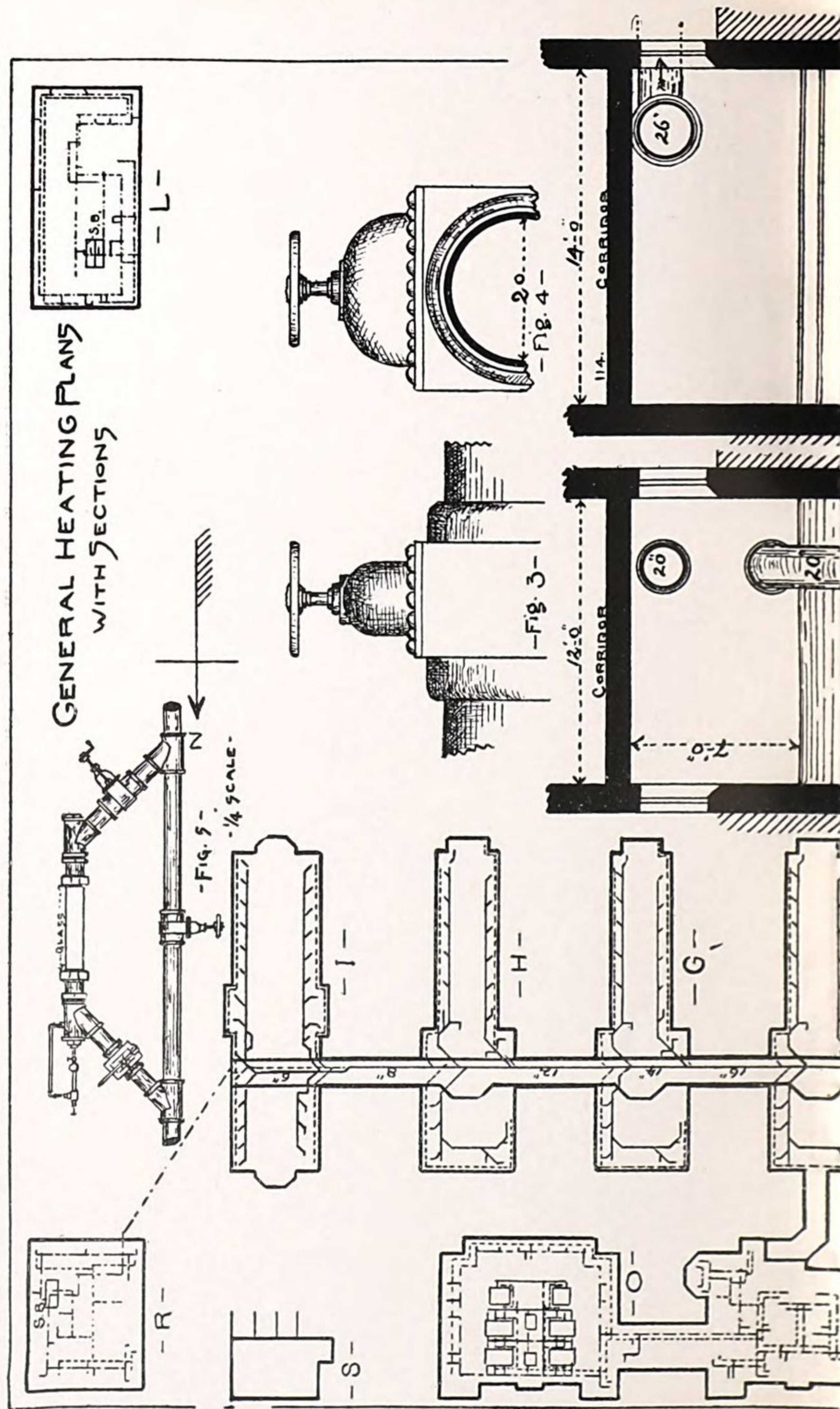
A	Administration building.	R	Pathological building.
X	Apothecary's building.	K	Kitchen.
B and C	Pay wards.	L	Laundry.
D, E, F, G, and H	Wards.	Y	Bath house.
I	Isolating ward.	T	Gate lodge.
O	Dispensary.	S	Stable.
U	Amphitheatre.	HW	Hot-water boilers.
N	Nurses' home.	SB	Steam boiler.

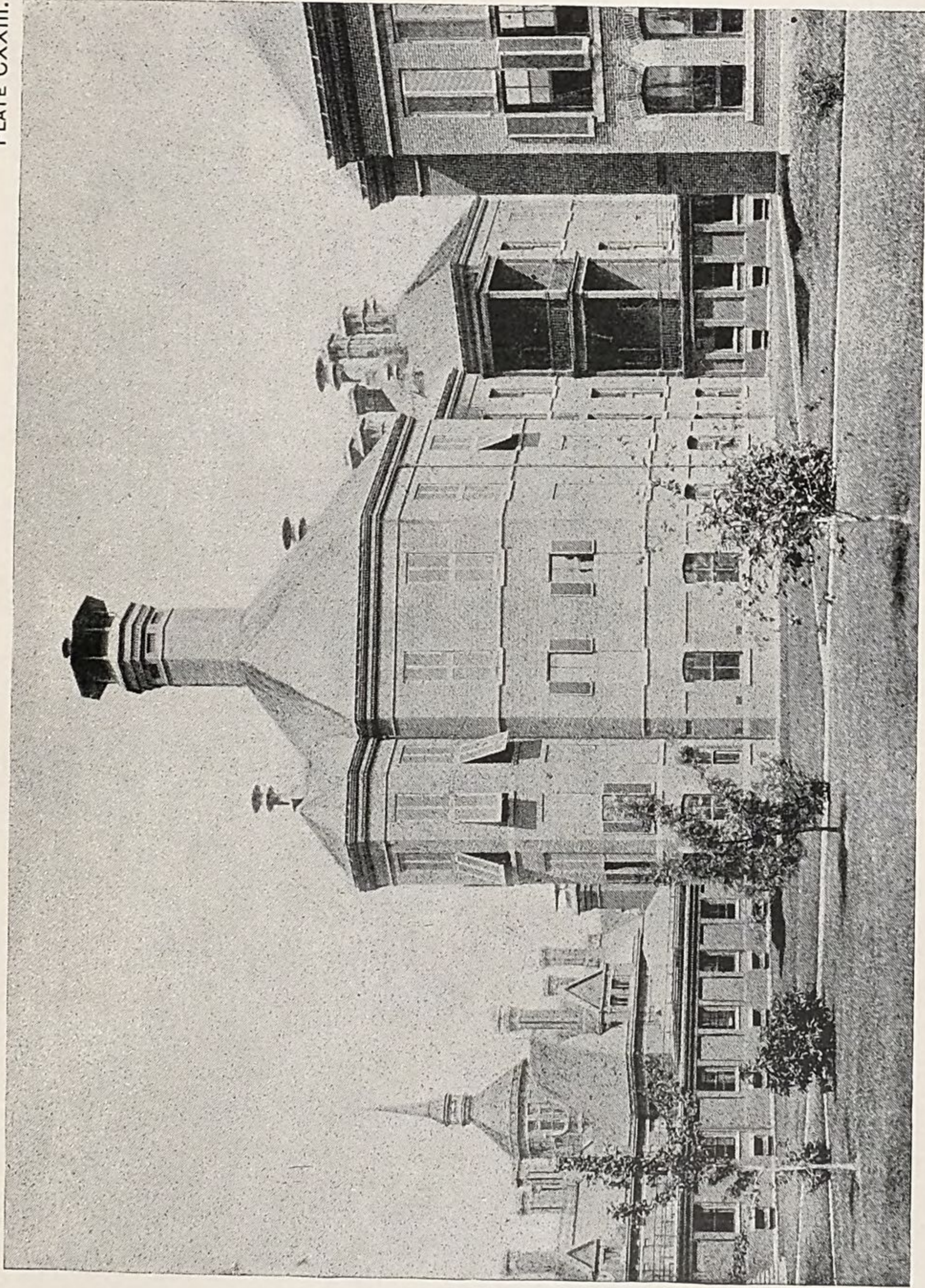
Fig. 1. Section of corridor at *a-b*, looking east.

Fig. 2. Section of corridor at *b-c*, looking north.

Figs. 3 and 4. Detail of cut-off valve V.

Fig. 5. Switch for testing the velocity of water in heating pipes.





JOHNS HOPKINS HOSPITAL—OCTAGON WARD, EXTERIOR.



JOHNS HOPKINS HOSPITAL



OCTAGON WARD, INTERIOR.

PLATE CXXV.

OCTAGON WARD.

Basement and floor plans.

Fig. 1. Basement plan.

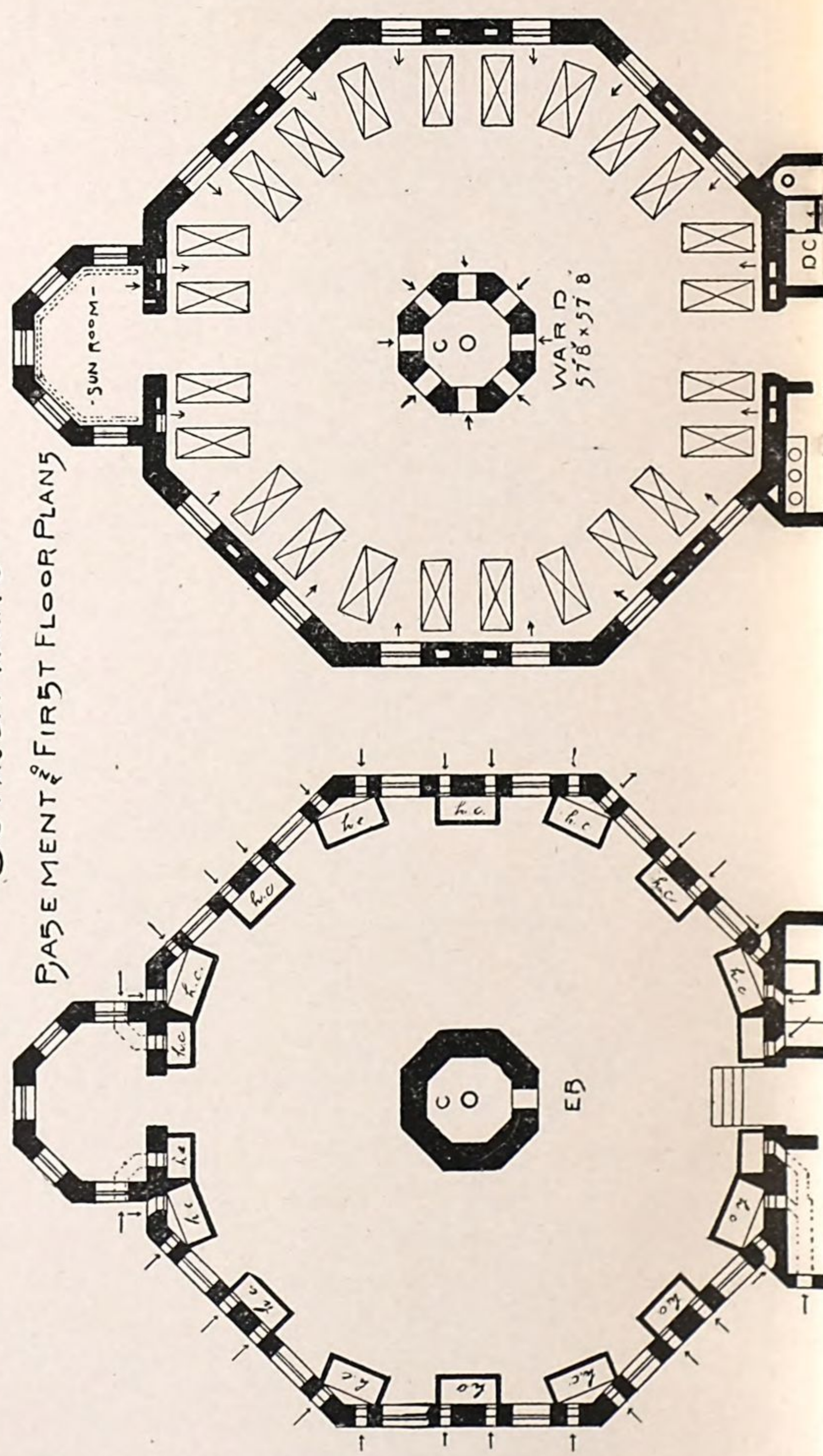
C	Central ventilating chimney.	L	Closet.
EB	Empty basement.	hc	Heat coils.
O	Orderlies.	F	Food lift.
CCo	Covered corridor.	V	Ventilating shaft for lift.
SR	Store room.	CL	Coal and soiled-clothes lift.

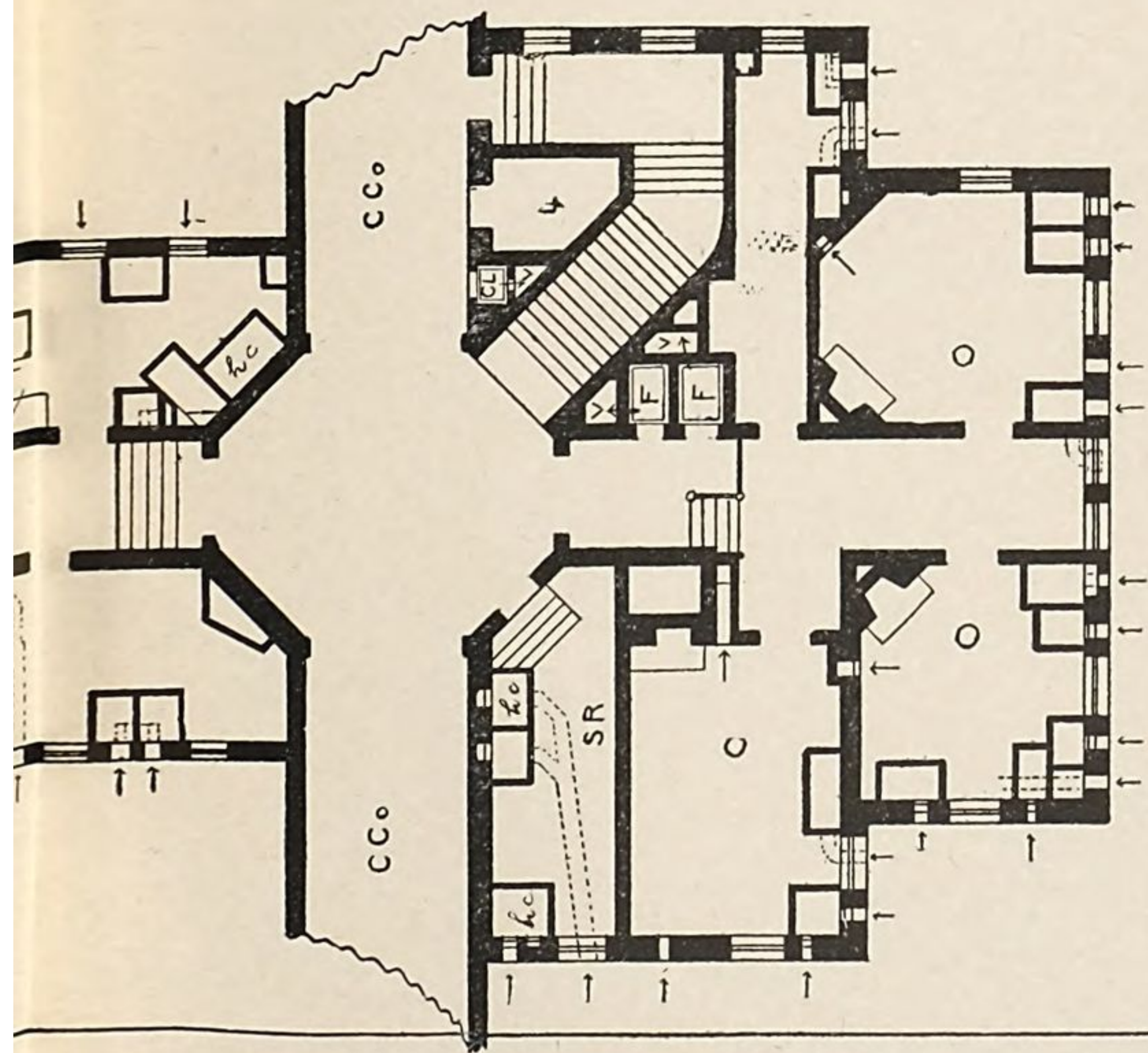
Fig. 2. Main floor plan.

C	Central ventilating chimney.	NC	Nurses' closet.
V	Ventilating shaft for lift.	CL	Coal and soiled-clothes lift.
H	Central hall.	R	Range.
PW	Private wards.	F	Food lifts.
W	Lavatory.	K	Sink.
B	Bathroom.	DC	Drying closet.
WC	Water-closets.	SR	Storeroom.
PC	Patients' clothing.	T	Open terrace over corridor.
L	Clean-linen closet.		

OCTAGON WARD

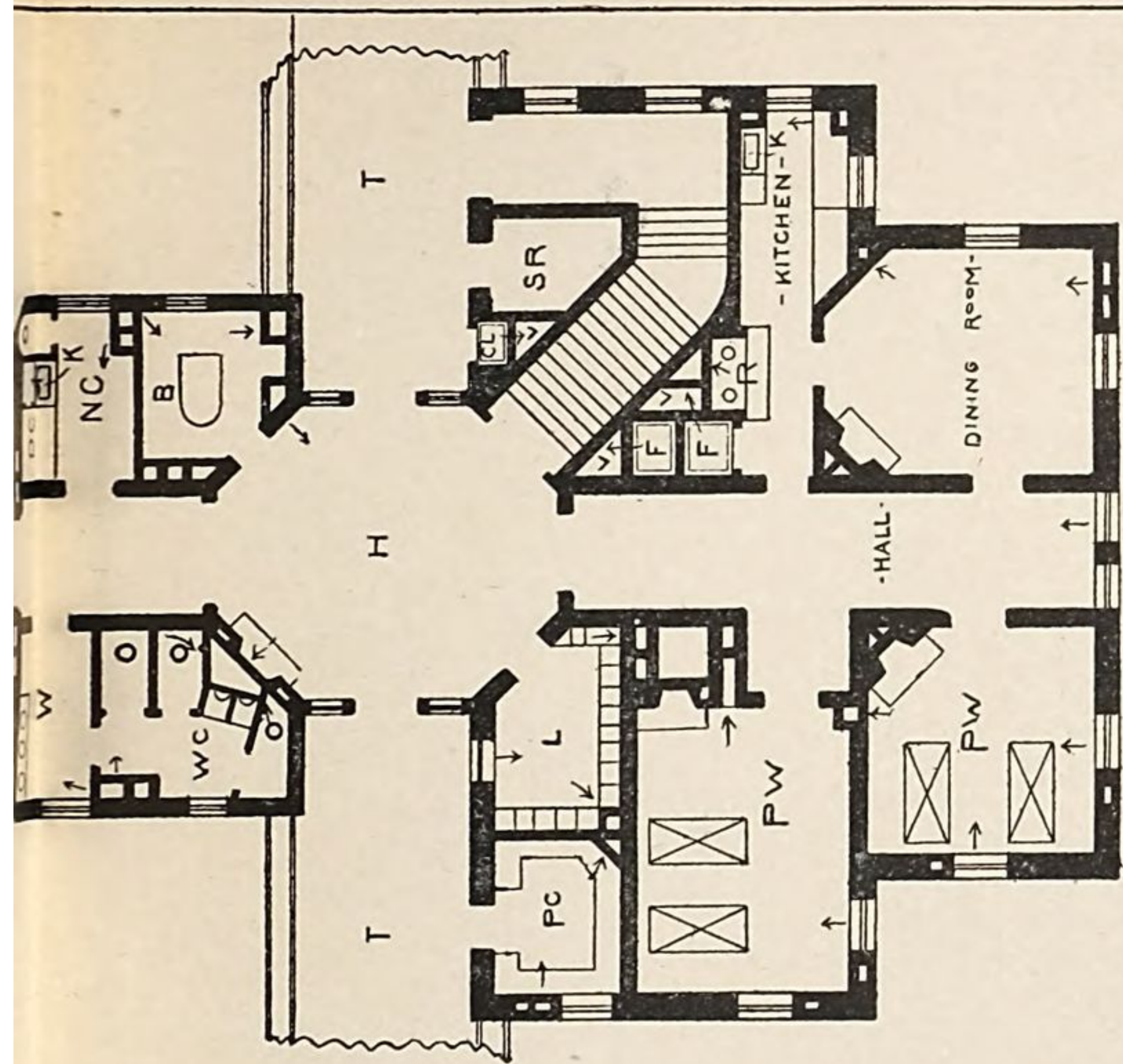
BASEMENT & FIRST FLOOR PLANS





- FIG 1 -

- SCALE - ONE INCH - 20 FEET -



- FIG. 2 -

JOHNS HOPKINS HOSPITAL.

PLATE CXXVI.

OCTAGON WARD.

Longitudinal and transverse sections.

Fig. 1. Longitudinal section, north and south

C	Central ventilating chimney.	Co	Corridor.
BC	Boiler-iron cylinder.	PT	Pipe tunnel.
AC	Accelerating steam coils.	B	Basement floor.
VWC	Vent pipe from water-closet.	D	Main floor.
V	Ventilator for water-closet, bath-room, and lavatory.	E	Second floor.
VS	Ventilator for special wards.	G	Attic floor.
VL	Ventilator for linen closet and clothes room.	DC	Chimney damper.
		S	Smoke pipe.

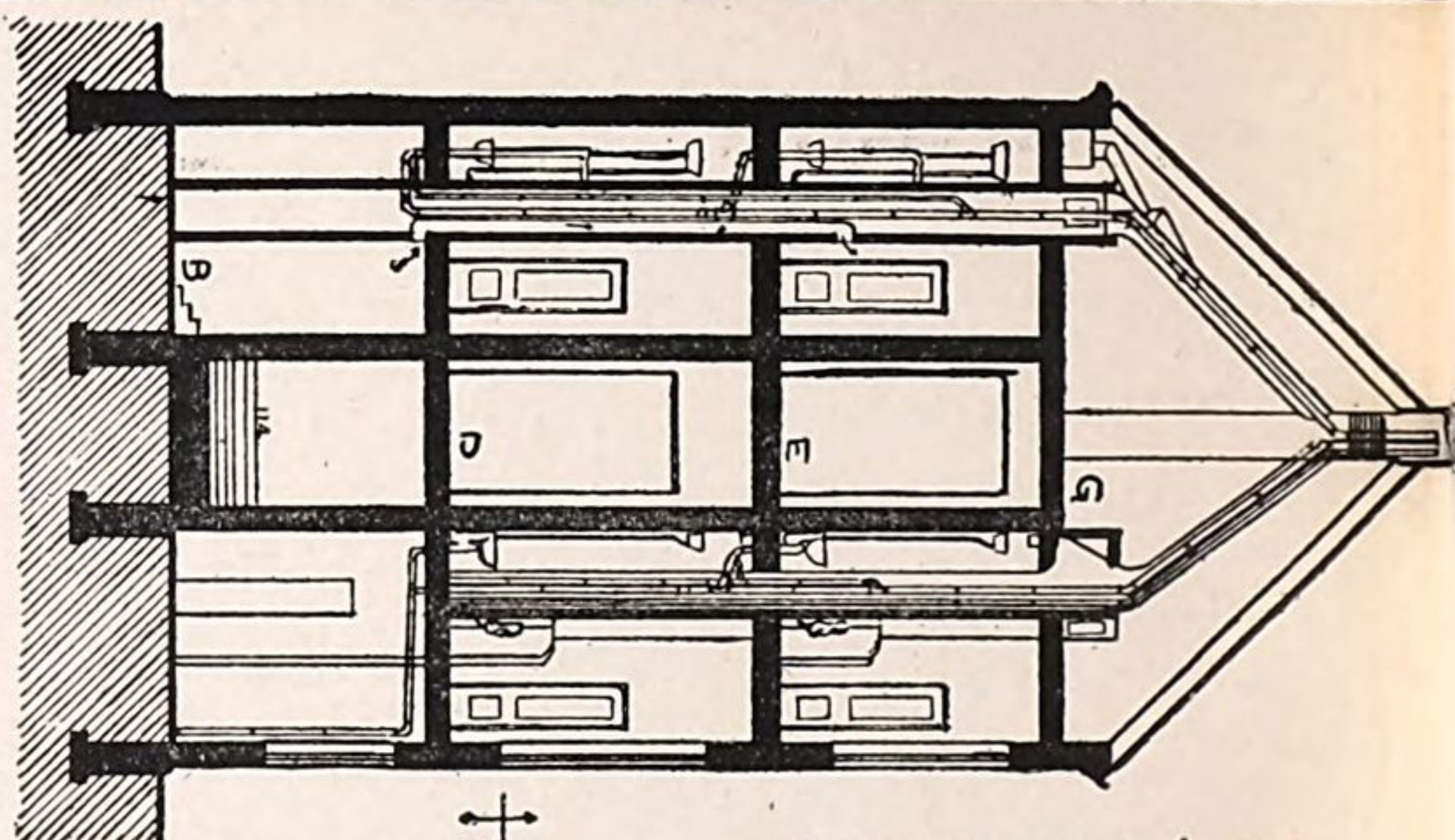
Fig. 2. Transverse section through water-closets, dry closets, etc., east and west.

V	Ventilator for water-closet, bath-room, and lavatory.	D	Main floor.
		E	Second floor.
B	Basement floor.	G	Attic floor.

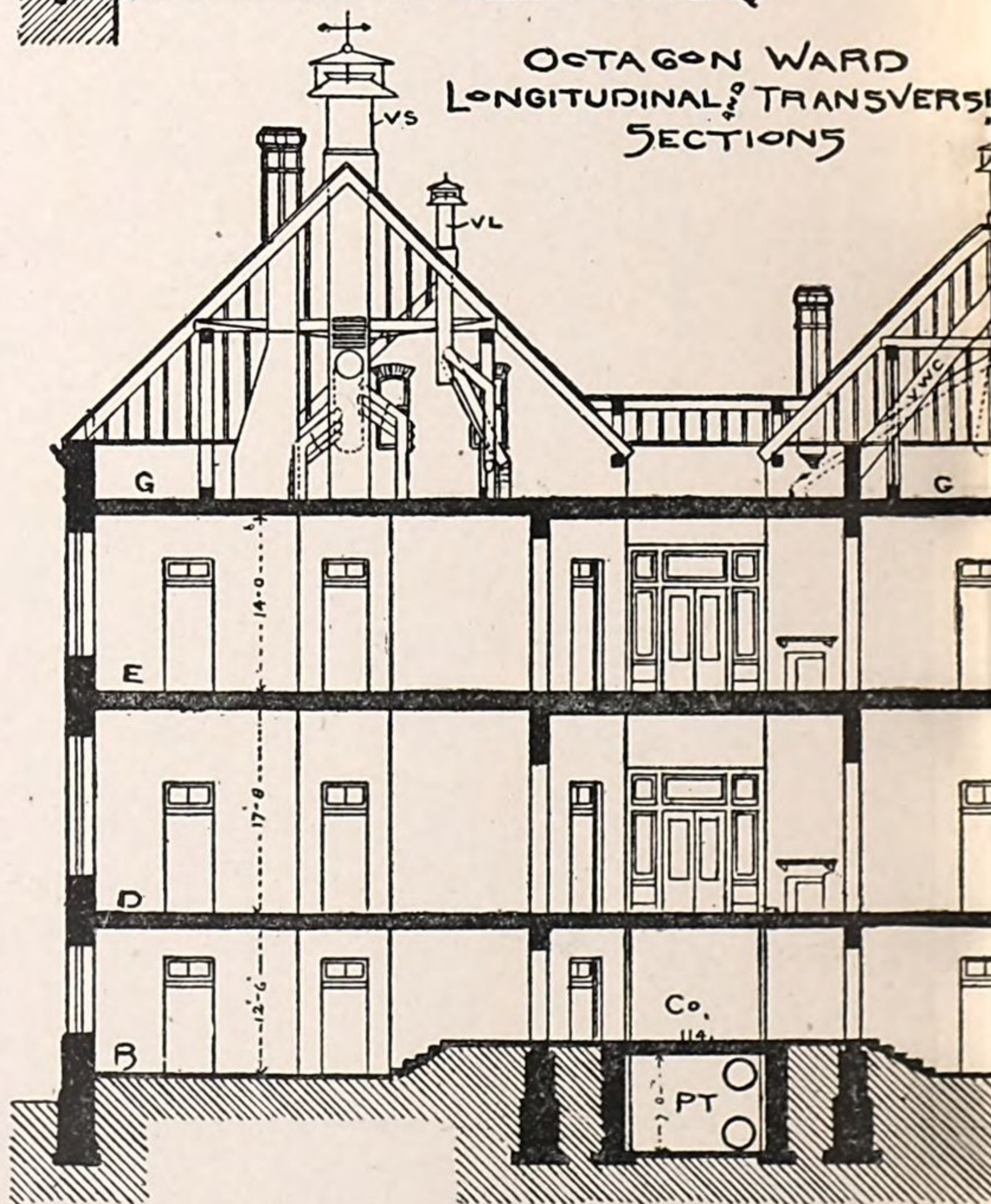
Fig. 3. Section of ventilating chimney, showing damper.

Fig. 4. Plan of chimney damper.

—FIG. 2—



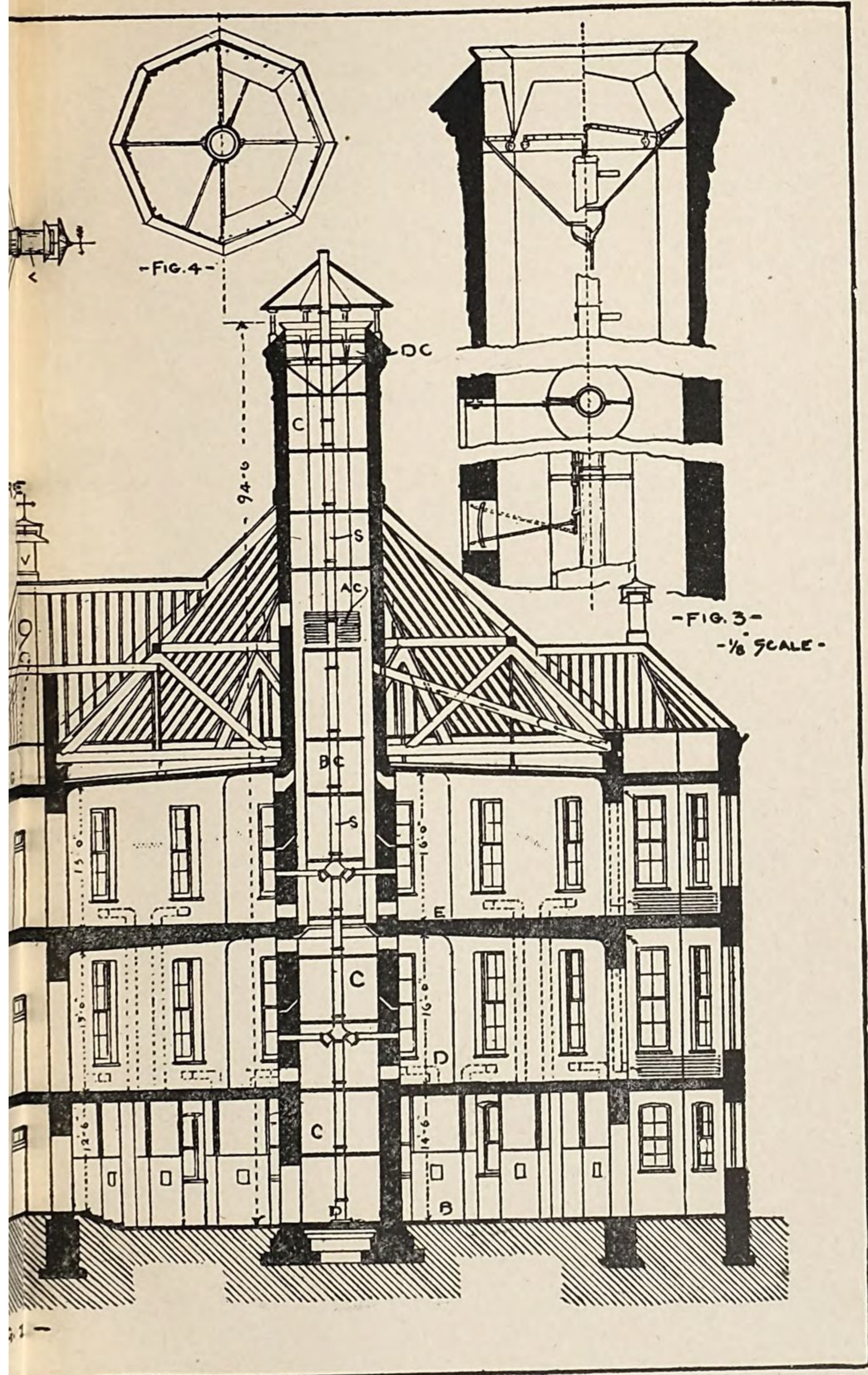
OCTAGON WARD
LONGITUDINAL & TRANSVERSE
SECTIONS

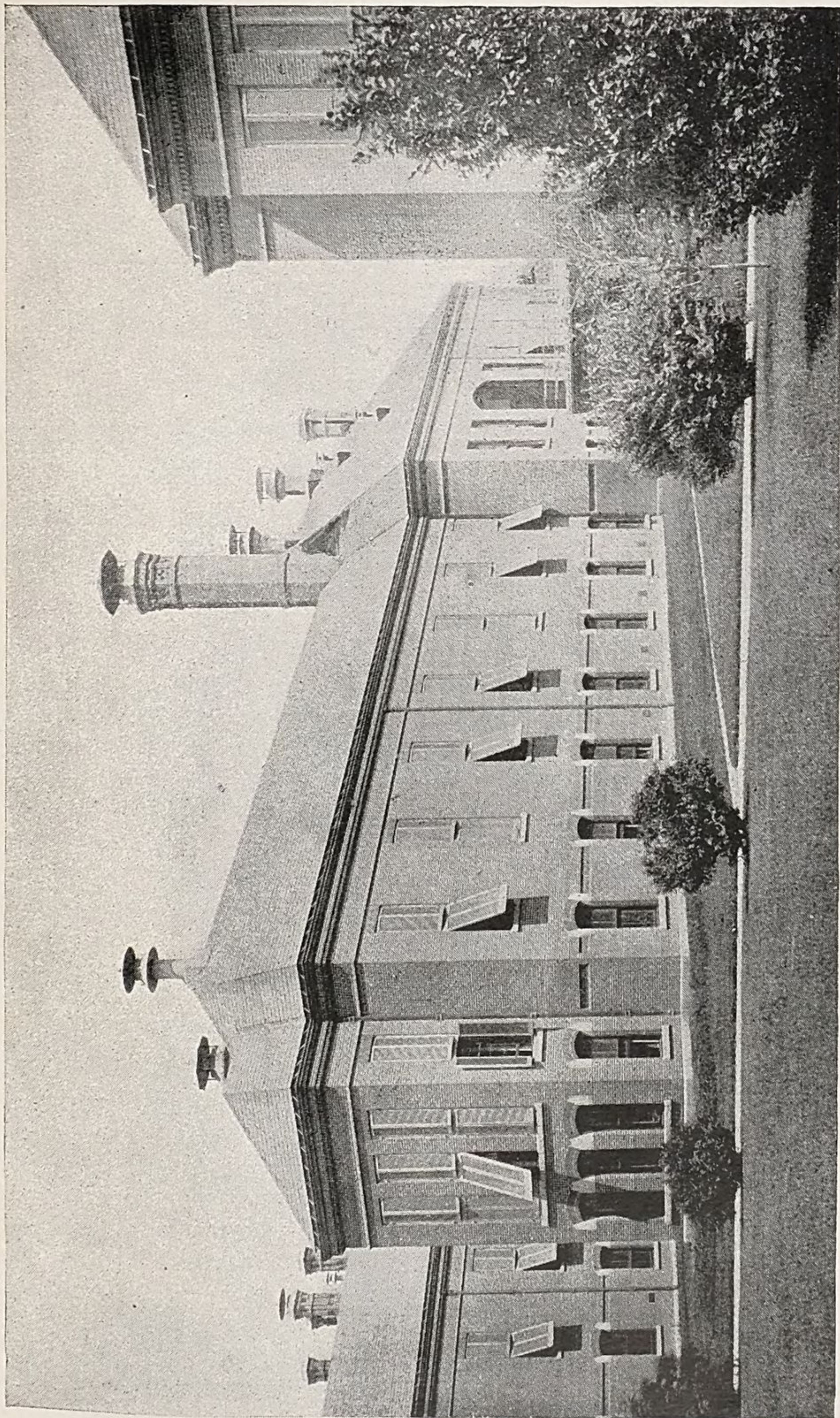


—FIG. 3—

—SCALE—20 FT. TO AN INCH—

JOHNS HOP

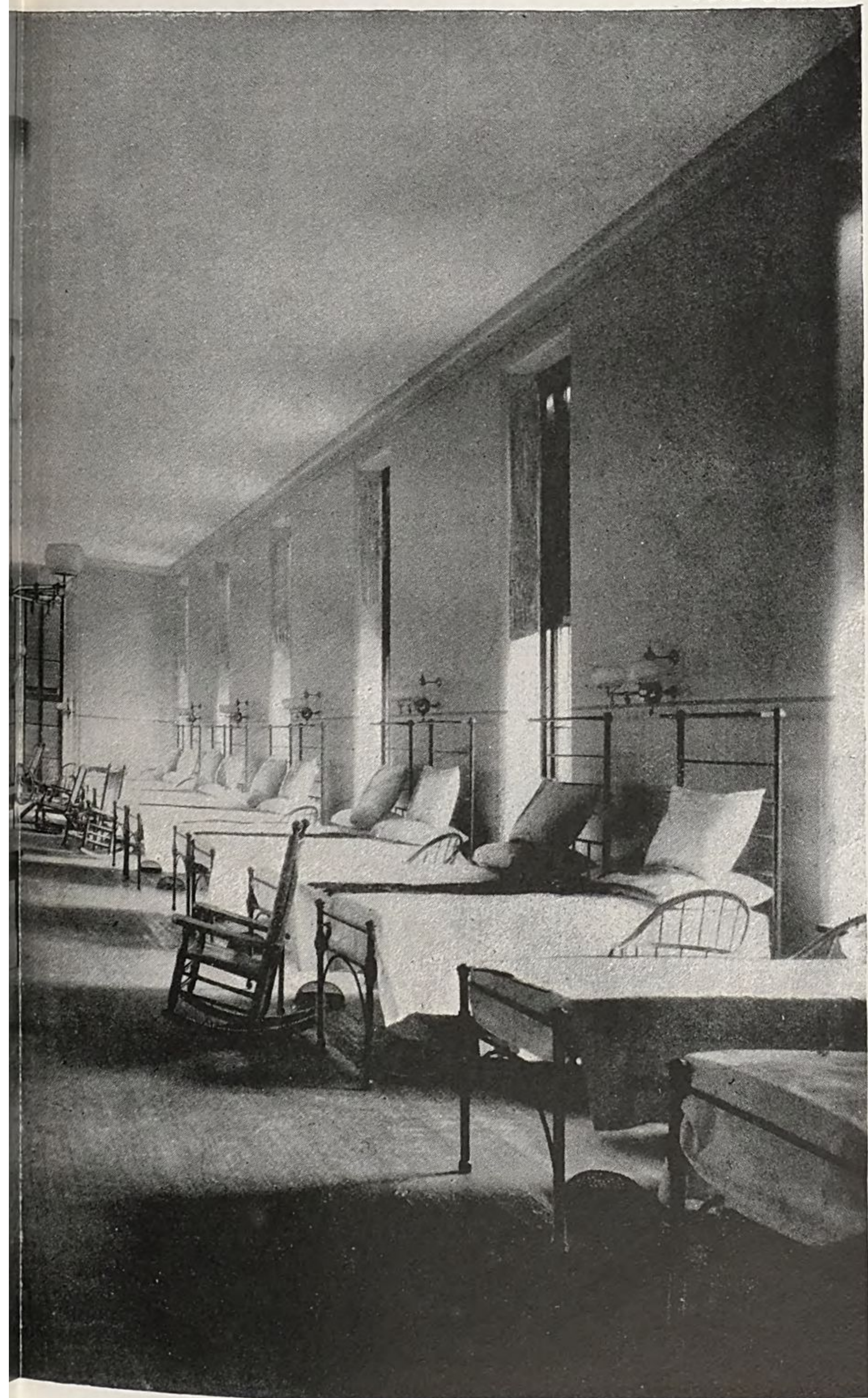




JOHNS HOPKINS HOSPITAL—COMMON WARD, EXTERIOR.



JOHNS HOPKINS HOSPITAL



COMMON WARD, INTERIOR.

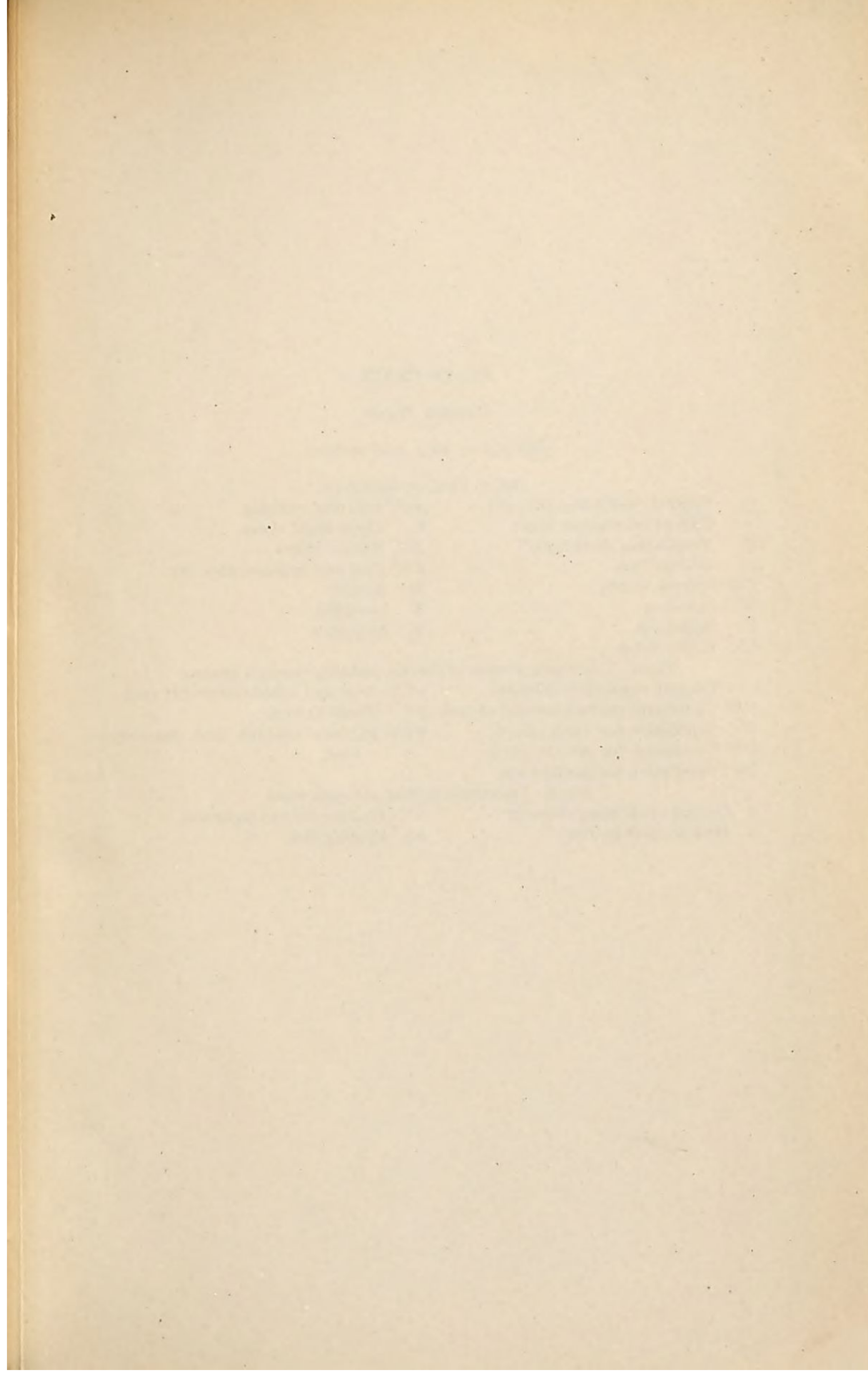


PLATE CXXIX.

COMMON WARD.

Main floor plan and sections.

Fig. 1. Plan of ward floor.

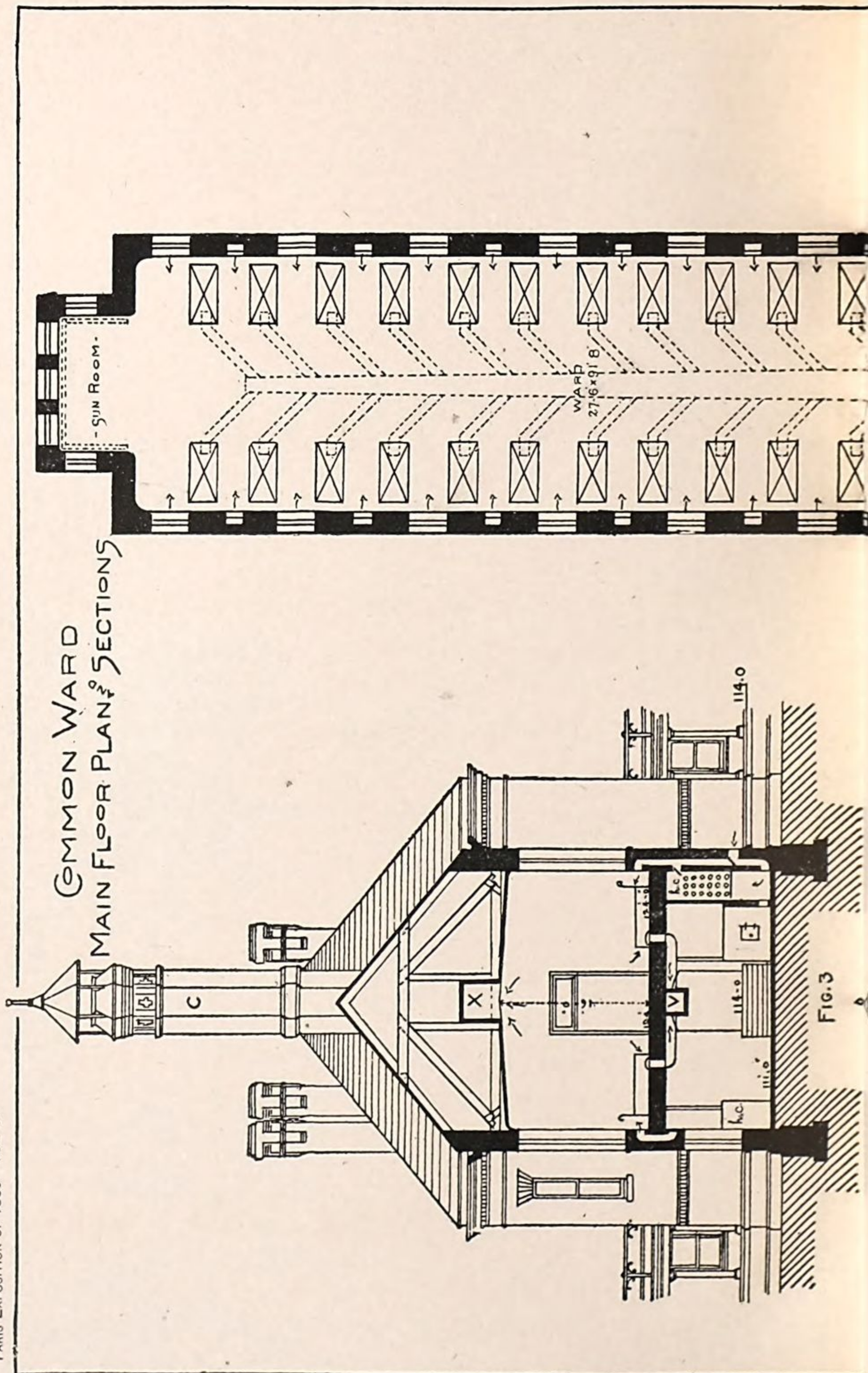
C	Central ventilating chimney.	PC	Patients' clothing.
V	Exit of ventilating ducts.	L	Clean-linen closet.
U	Ventilating shaft for lift.	NC	Nurses' closet.
H	Central hall.	CL	Coal and soiled-clothes lift.
PW	Private wards.	R	Range.
W	Lavatory.	F	Food lift.
B	Bathroom.	K	Slop sink.
WC	Water-closet.		

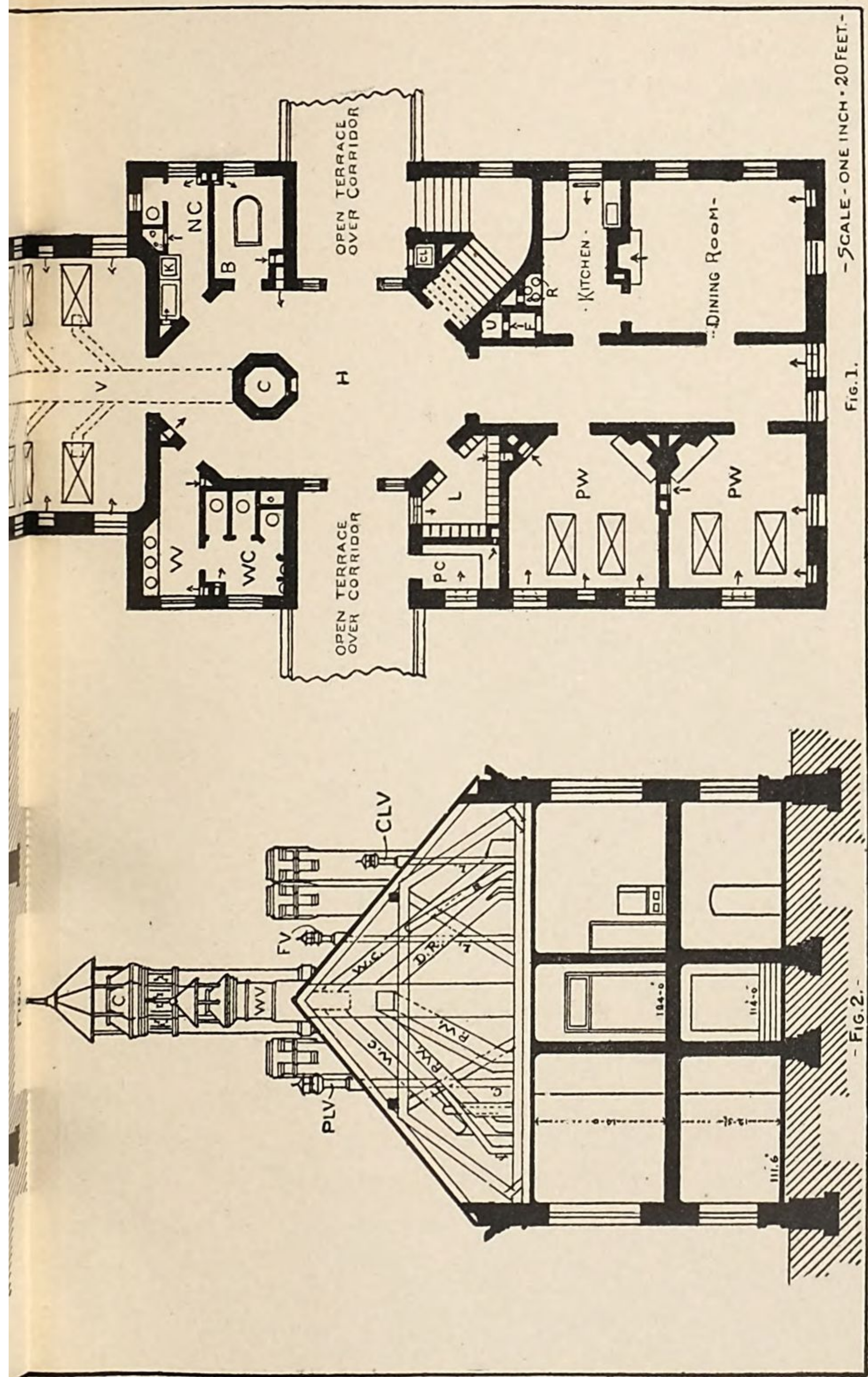
Fig. 2. Transverse section of service building through kitchen.

C	Central ventilating chimney.	CLV	Coal and soiled-clothes lift vent.
VW	Ventilating shafts for water-closets.	FV	Food-lift vent.
WC	Ventilation for water-closets.	PLV	Patients' clothing and clean-linen vent.
PW	Ventilation for private wards.		
DR	Ventilation for dining room.		

Fig. 3. Transverse section through ward.

C	Central ventilating chimney.	V	Foul-air duct in basement.
X	Foul-air duct in attic.	hc	Heating coil.





JOHNS HOPKINS HOSPITAL.

PLATE CXXX.

COMMON WARD.

Basement and attic floor plans.

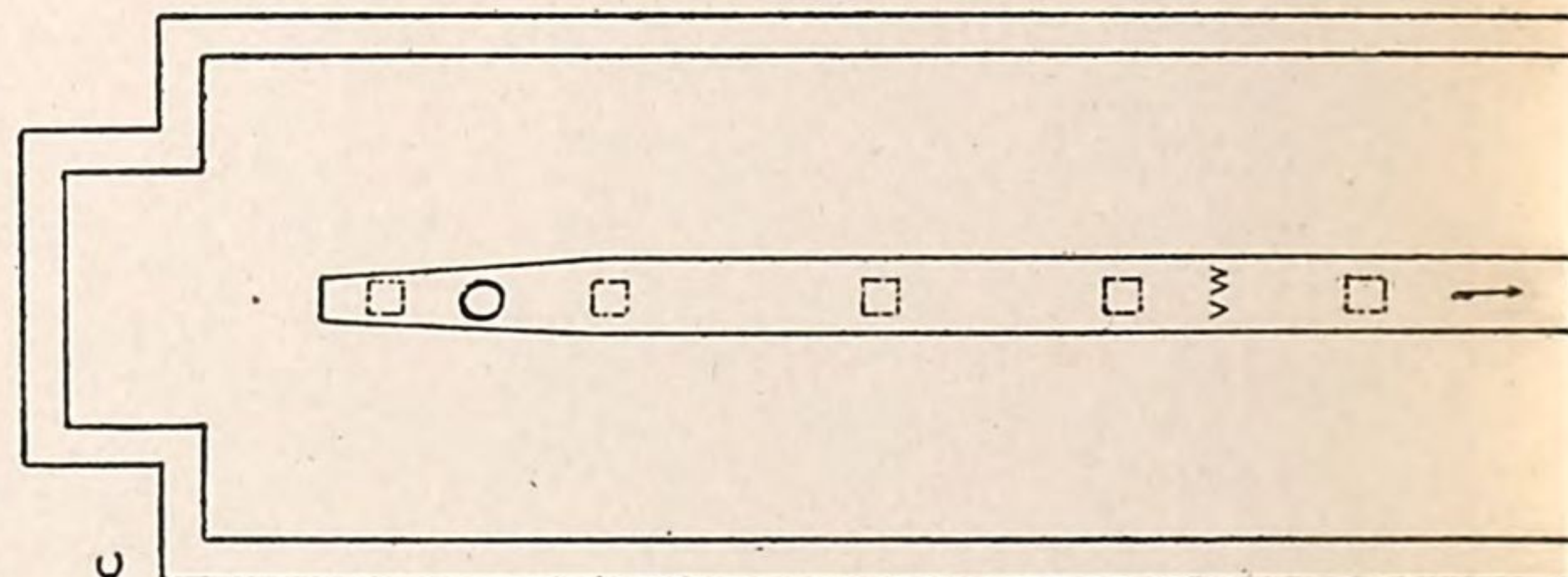
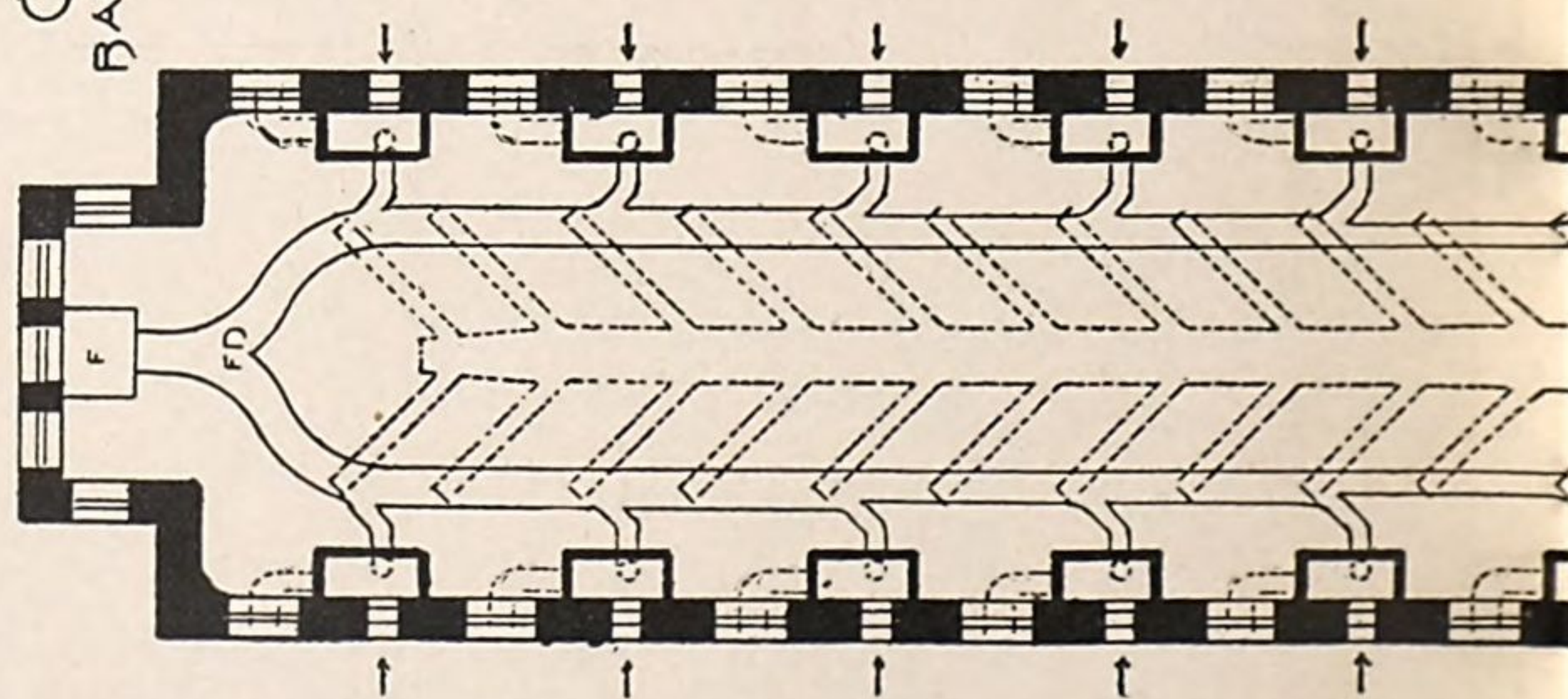
Fig. 1. Basement.

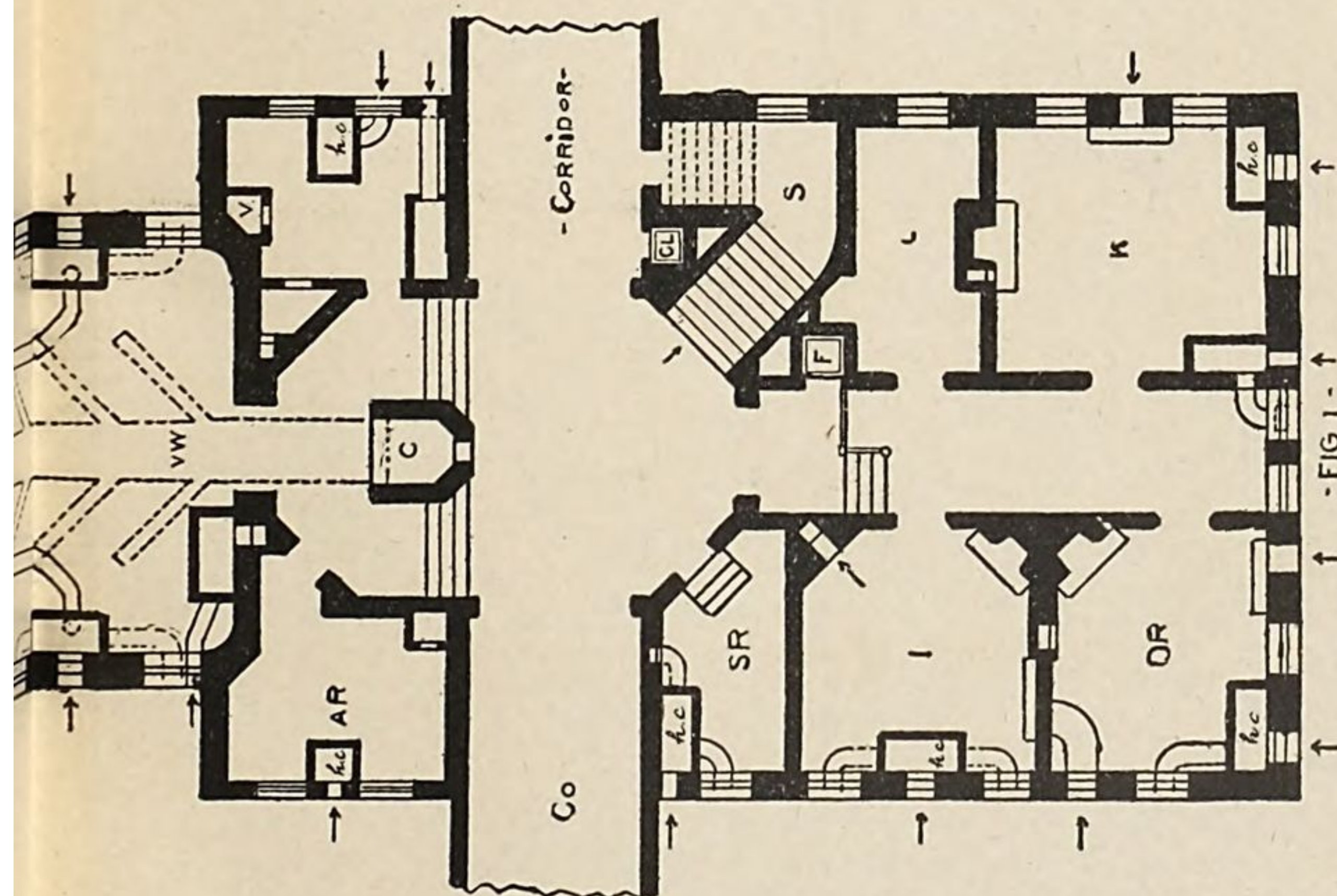
C	Central ventilating chimney.	S	Stairway.
VW	Ventilating duct from ward floor.	I, K, and L	Clinical laboratory.
V	Vent shaft to water-closet and nurses' closets.	DR	Directors' room.
AR	Airing room for blankets, beds, etc.	Co	Corridor.
hc	Heating coils.	SR	Storeroom.
FD	Fan duct.	CL	Coal and soiled-clothes lift.
F	Fan.	F	Food lift.

Fig. 2. Plan of attic story.

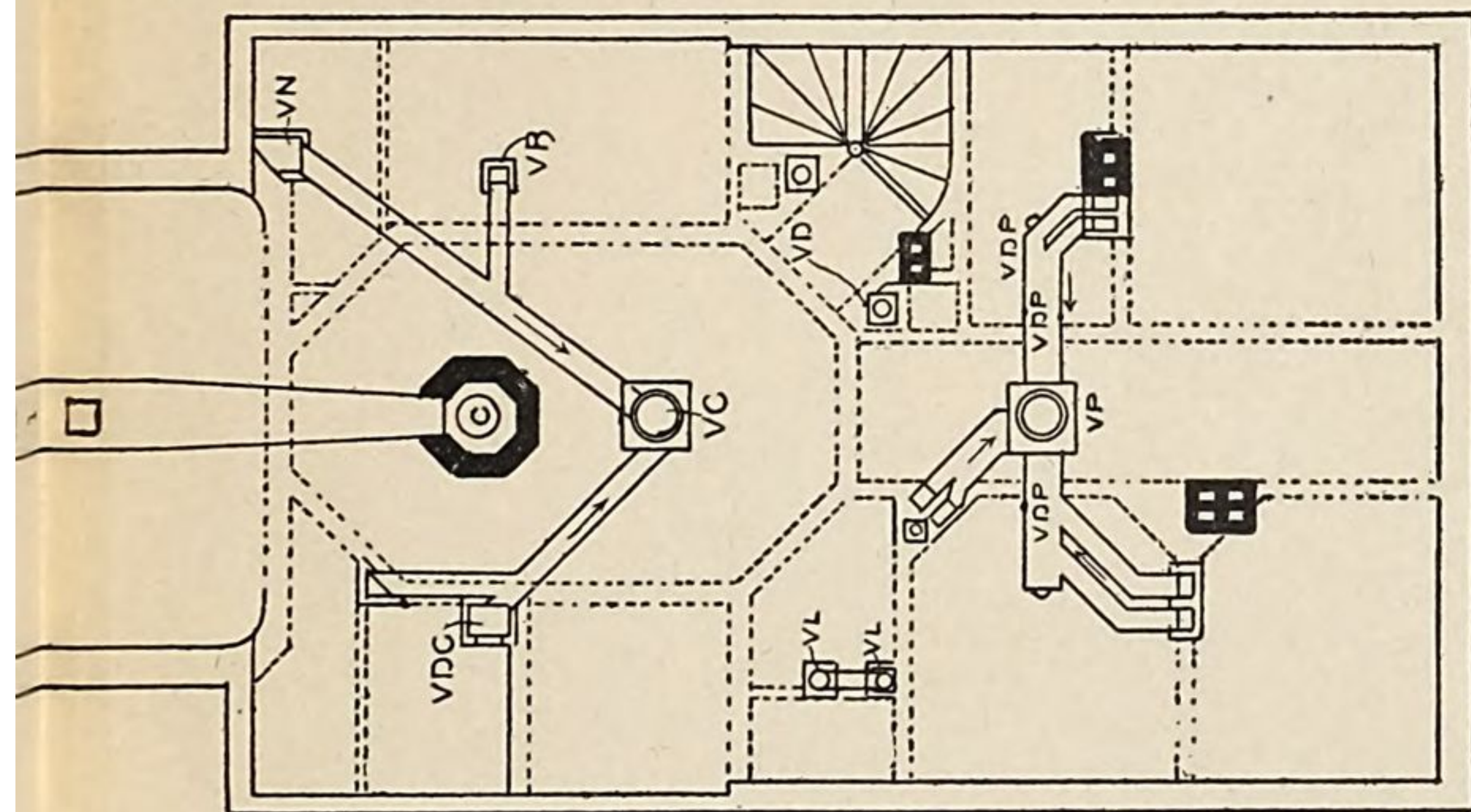
C	Central ventilating chimney.	VN	Vent to nurses' closet, slop hopper, water-closets, and dry closets.
VW	Vent to ward ceiling.	VB	Vent to bathroom.
VP	Vent shaft, private wards.	VL	Vent to linen room and patients' clothes room.
VDP	Vent ducts, private wards.	VD	Lift vent.
VC	Vent shaft to water-closets, baths, etc.		
VDC	Vent ducts to water-closets.		

COMMON WARD
BASEMENT & ATTIC
FLOOR PLANS





- FIG 1 -



JOHNS HOPKINS HOSPITAL.

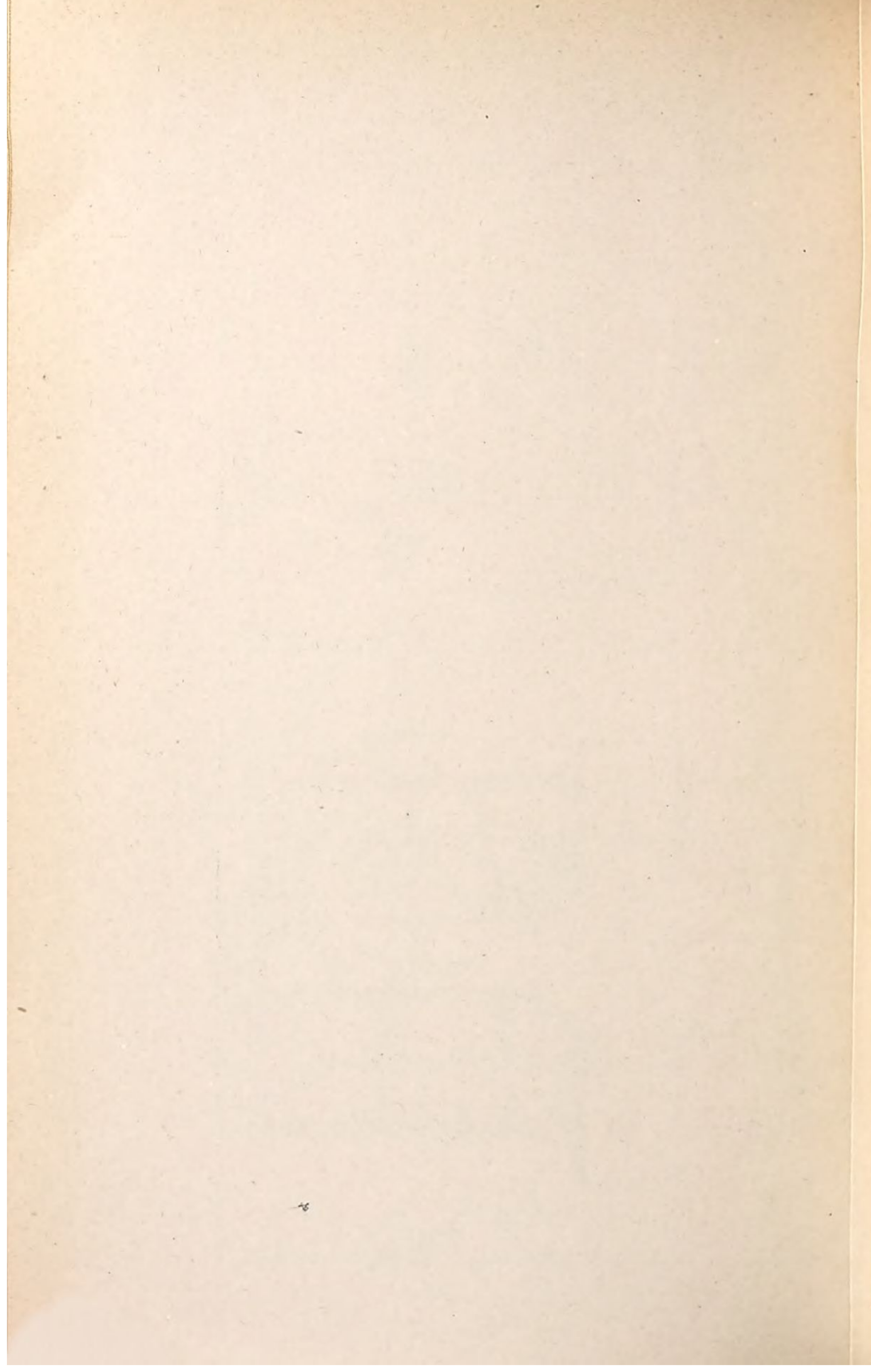


PLATE CXXXI.

COMMON WARD.

Longitudinal section, north and south.

Fig. 1. Longitudinal section of ward.

B	Basement floor.	WC	Vent pipe from water-closets.
D	Main floor.	DR	Vent pipe from dining room.
G	Attic floor.	PW	Vent pipe from private wards.
PT	Pipe tunnel.	GV	Attic ventilation.
C	Central ventilating chimney.	VD	Lift vent.
AC	Accelerating steam coils.	VL	Vent to linen and patients' clothes rooms.
X	Foul-air duct in attic.	VP	Vent shaft, private wards.
V	Foul-air duct in basement.	hc	Heat coils.
VW	Ventilating shaft for water-closets.		

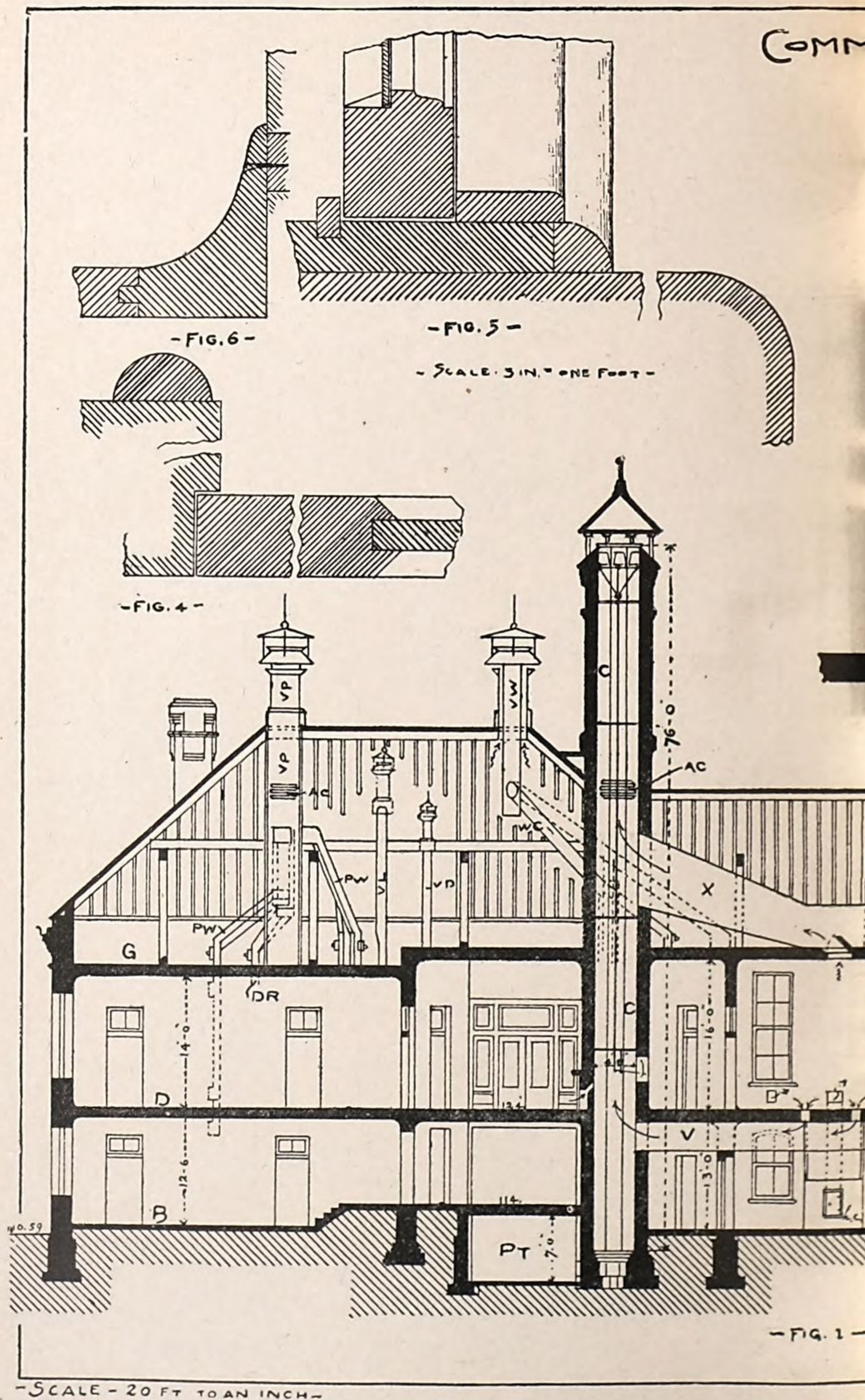
Fig. 2. Section of heating coil chamber.

Fig. 3. Section and plans of ventilating chimney, showing damper.

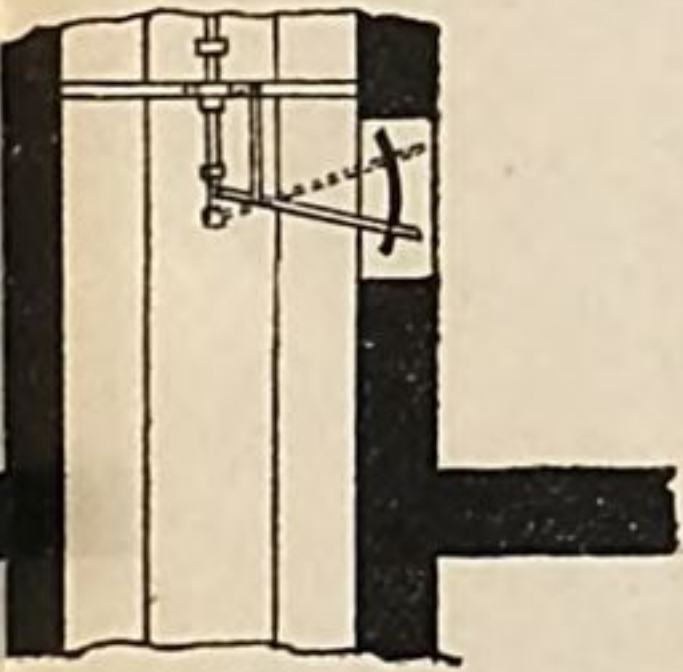
Fig. 4. Plan of doors, showing finish.

Fig. 5. Plan of windows, showing finish.

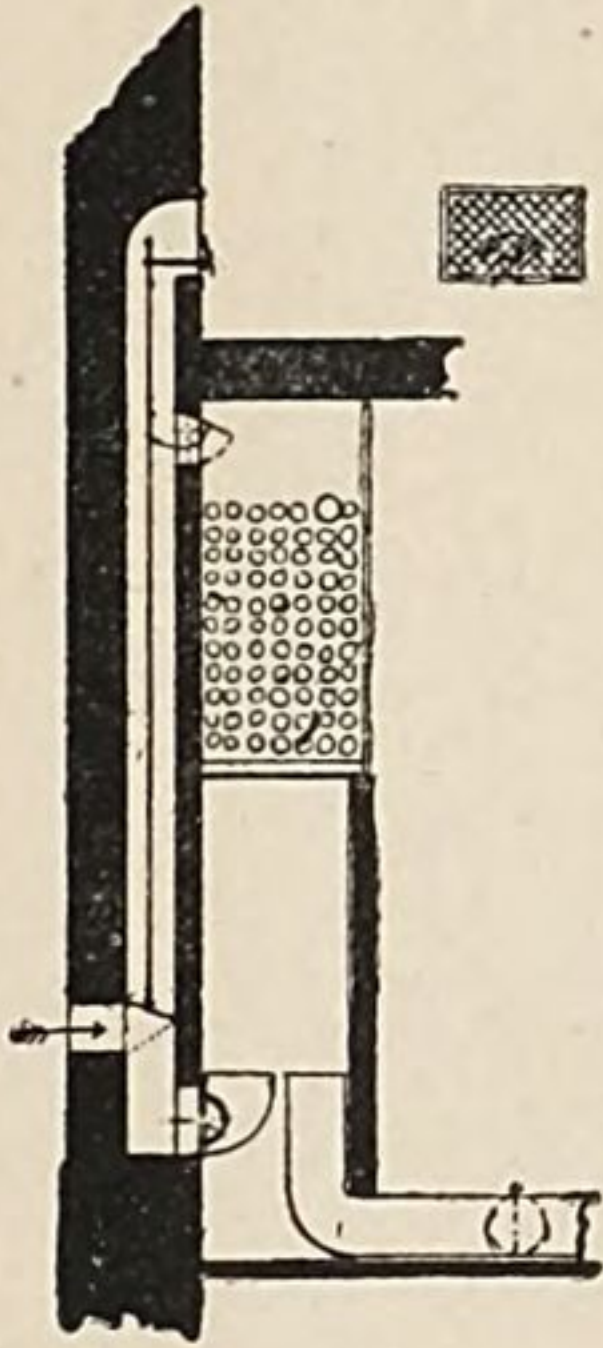
Fig. 6. Section of washboard.



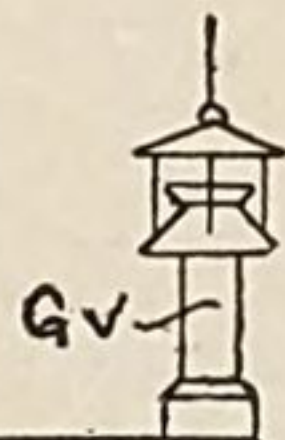
ON WARD-LONGITUDINAL SECTION NORTH² SOUTH



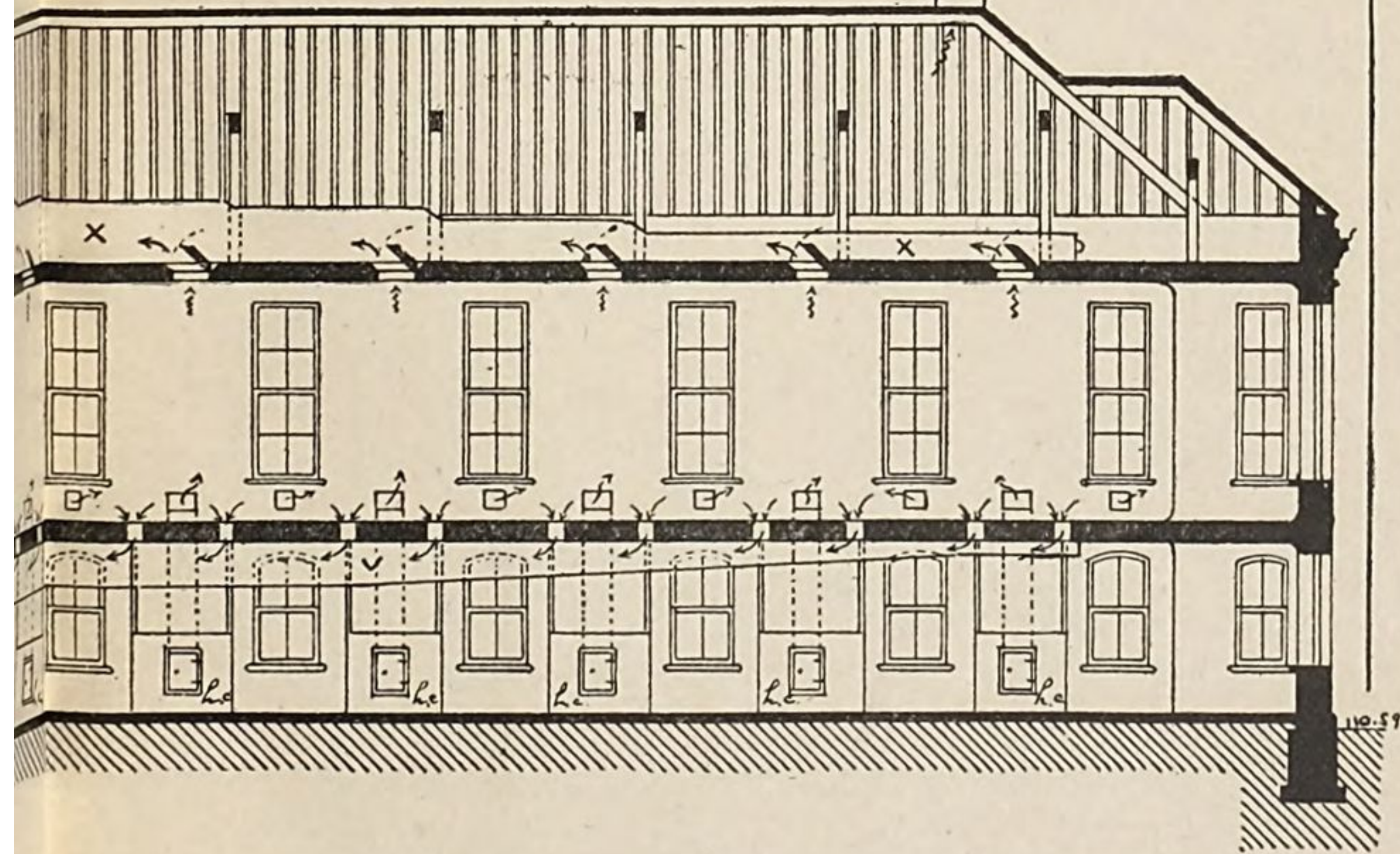
-FIG. 3-



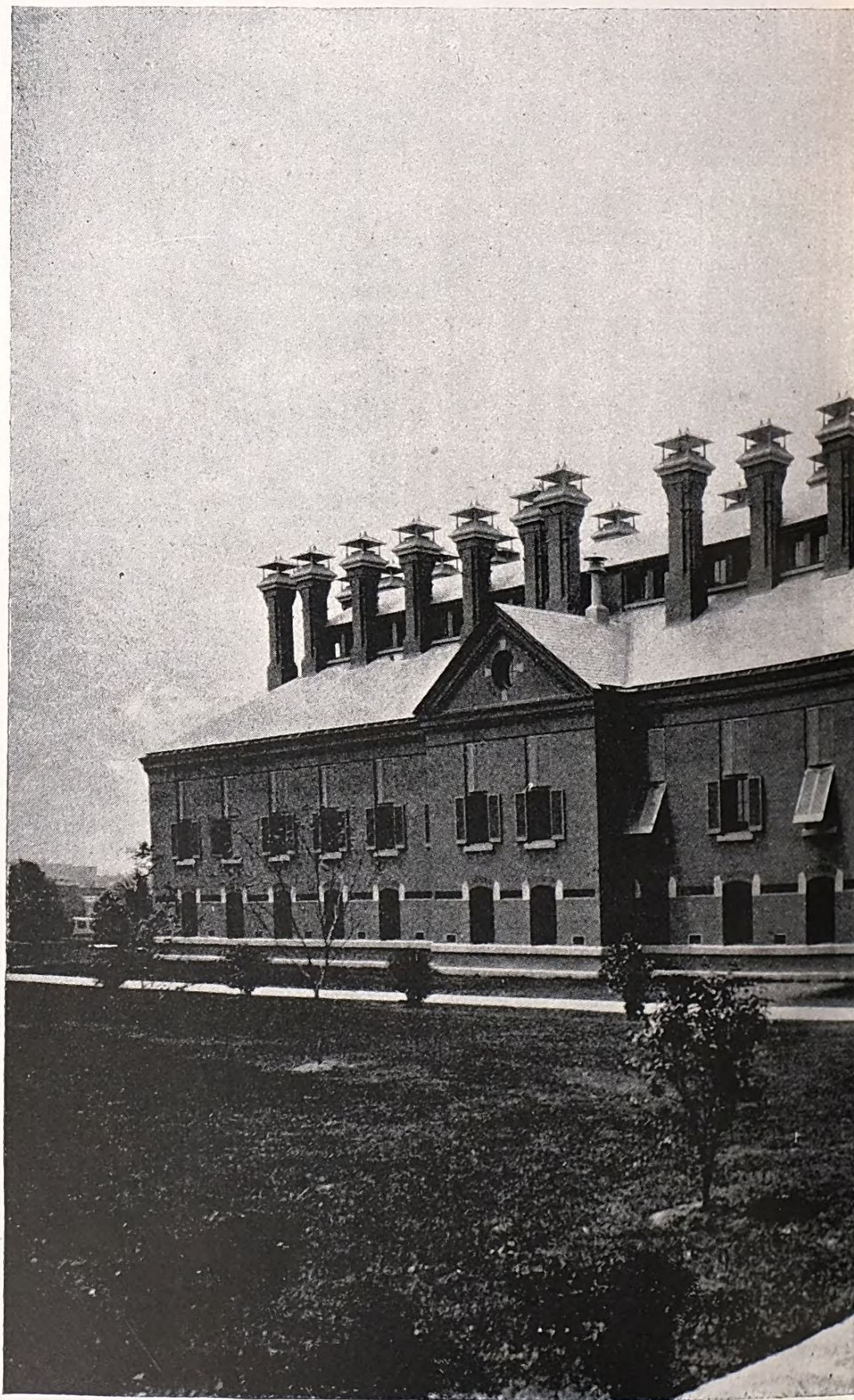
-FIG. 2-
- 1/8" SCALE -



GV



110.59



JOHNS HOPKINS HOSPITAL—19



ISOLATING WARD, EXTERIOR.

PLATE CXXXIII.

ISOLATING WARD.

Plans and transverse section.

Fig. 1. Plan of ward floor.

OC	Open-air corridor.	DC	Dry closet.
P	Patients' rooms.	WC	Water-closet.
I	Rooms with perforated floors.	T	Open terrace over corridor.
N	Nurses' rooms.	K	Sink.
DK	Diet kitchen.	By	Balcony.
F	Food lift.	D	Lift.
B	Bathroom.	S	Stairs.
L	Linen closet.		

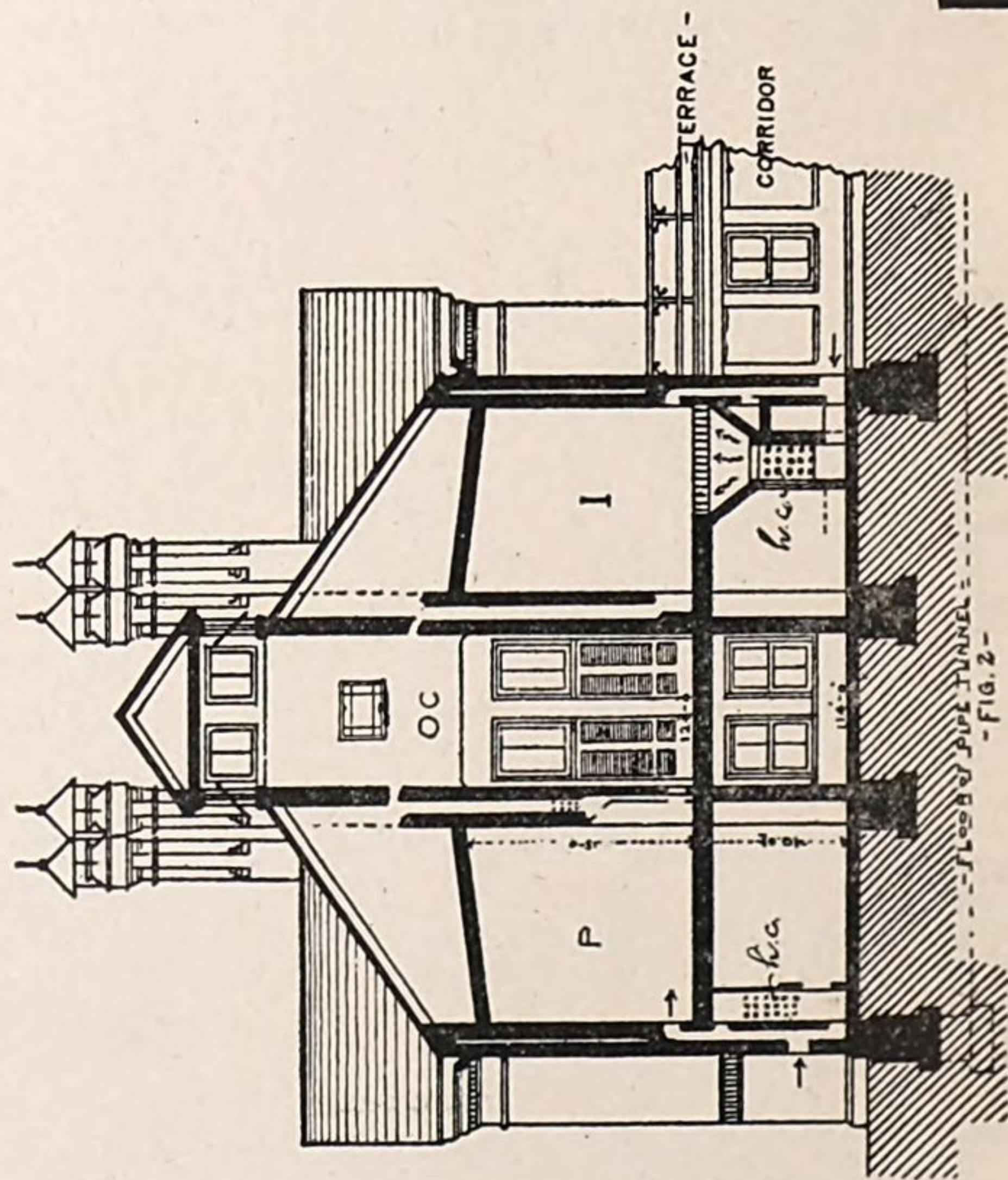
Fig. 2. Transverse section.

OC	Open-air corridor.	I	Rooms with perforated floors.
P	Patients' rooms.	hc	Heating coils.

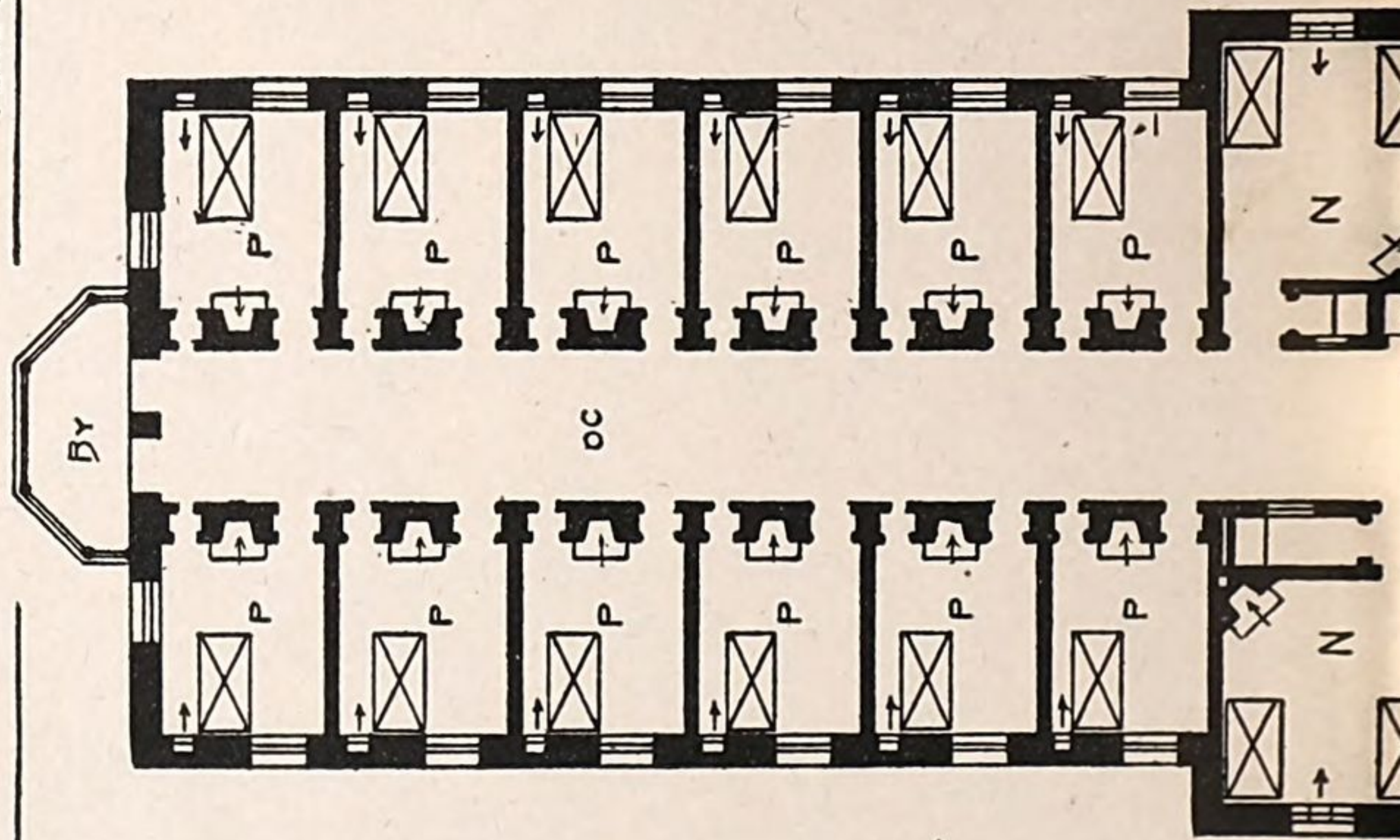
Fig. 3. Plan of north end of basement.

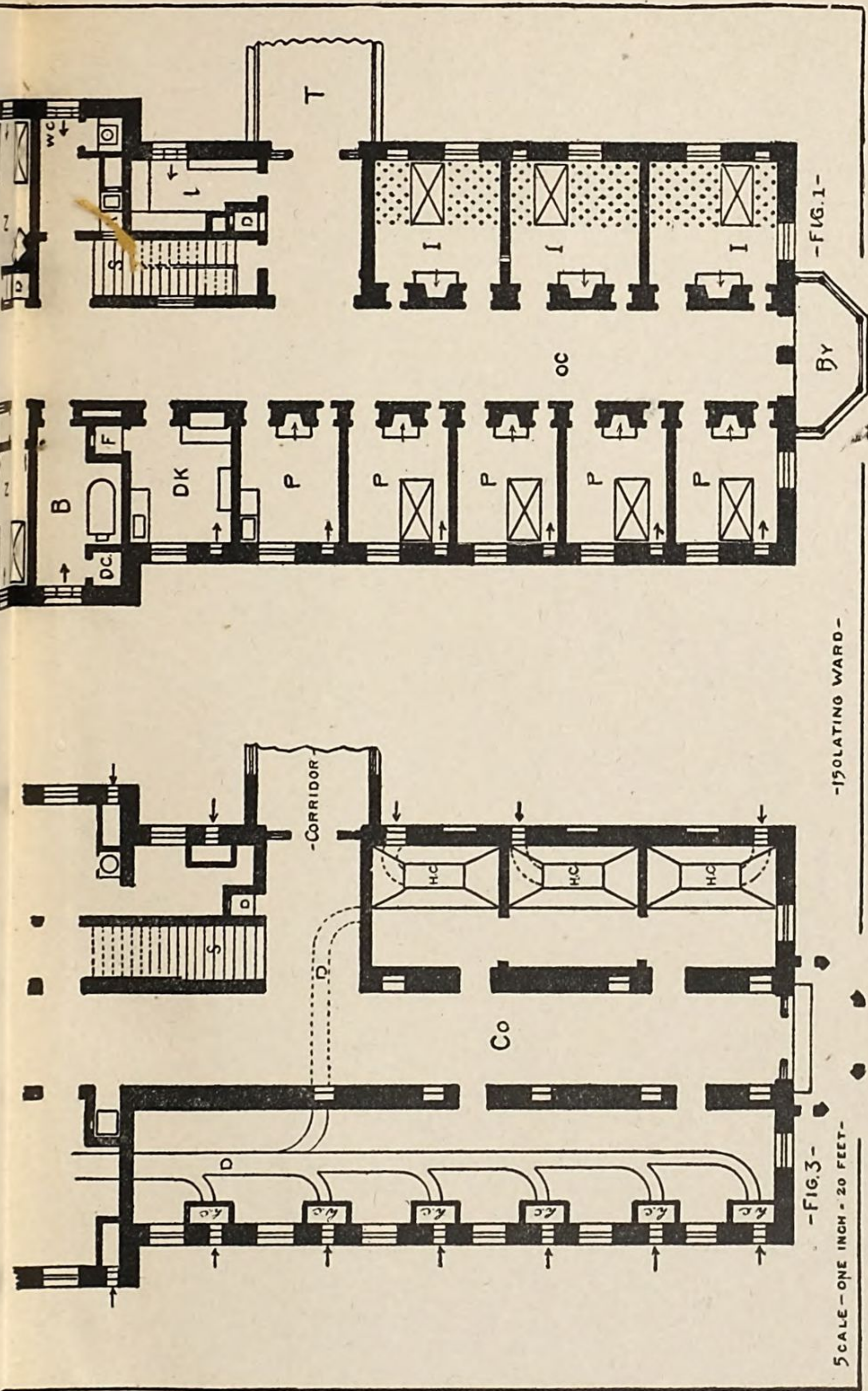
Co	Corridor.	D	Fan duct.
S	Stairs.	hc	Heating coils.

ISOLATING WARD
PLAN 5th TRANSVERSE SECTION



- FIG. 2 -





JOHNS HOPKINS HOSPITAL.

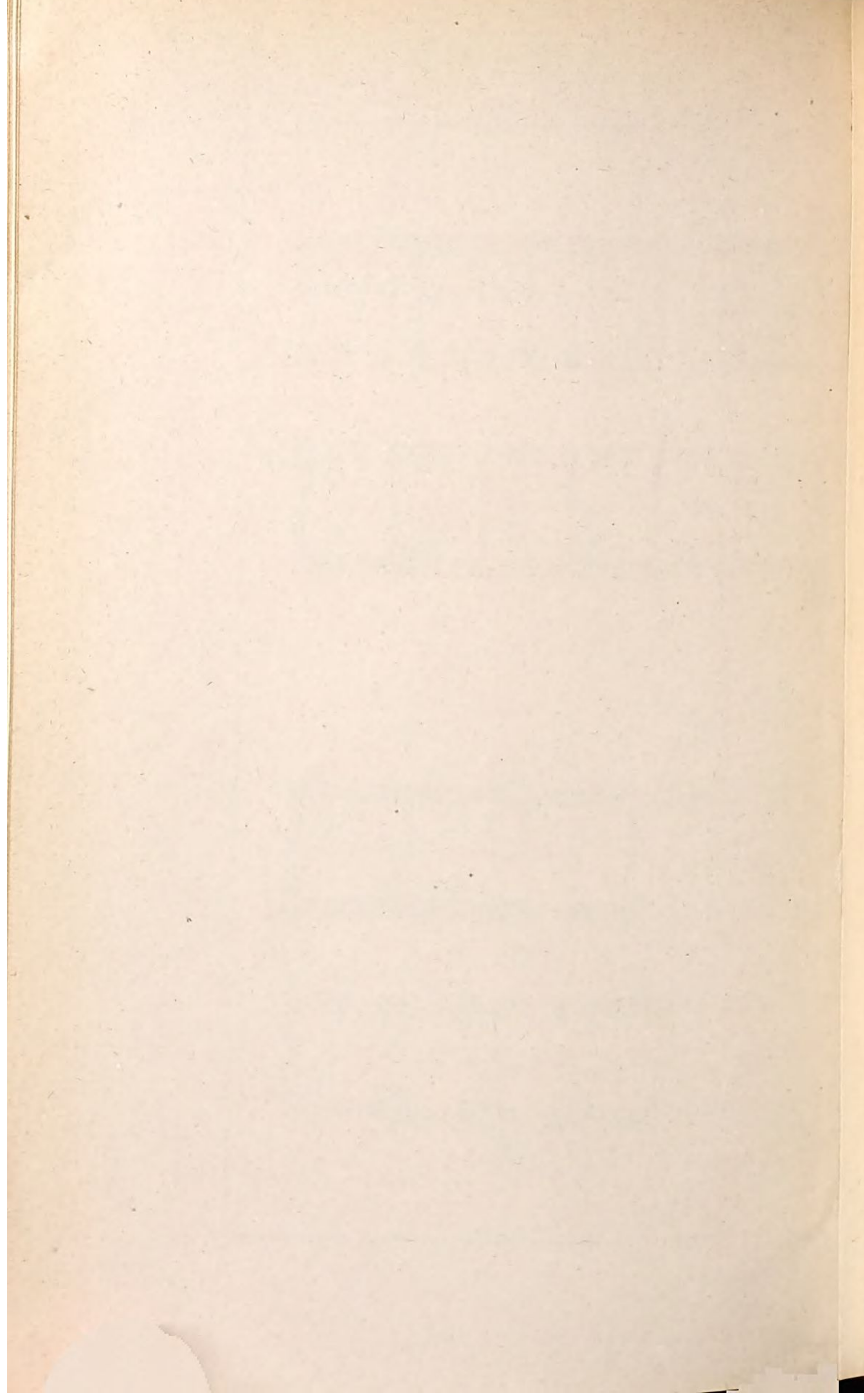


PLATE CXXXIV.

ISOLATING WARD.

Longitudinal section.

Fig. 1. Longitudinal section, north and south.

- | | | | |
|---|-----------------|----|-----------------------------------|
| B | Basement floor. | HC | Heat chambers for rooms with per- |
| D | Main floor. | | forated floors. |
| G | Attic floor. | PT | Pipe tunnel. |

Fig. 2. Longitudinal section of heat chamber of rooms with perforated floors.

Fig. 3. Transverse section of heat chambers.

Fig. 4. Plan of heat chambers.

Fig. 5. Transverse section of commode.

- | | | | |
|---|-------------------|----|--------------------------|
| V | Ventilating flue. | AC | Accelerating steam coil. |
| | | WC | Commode. |

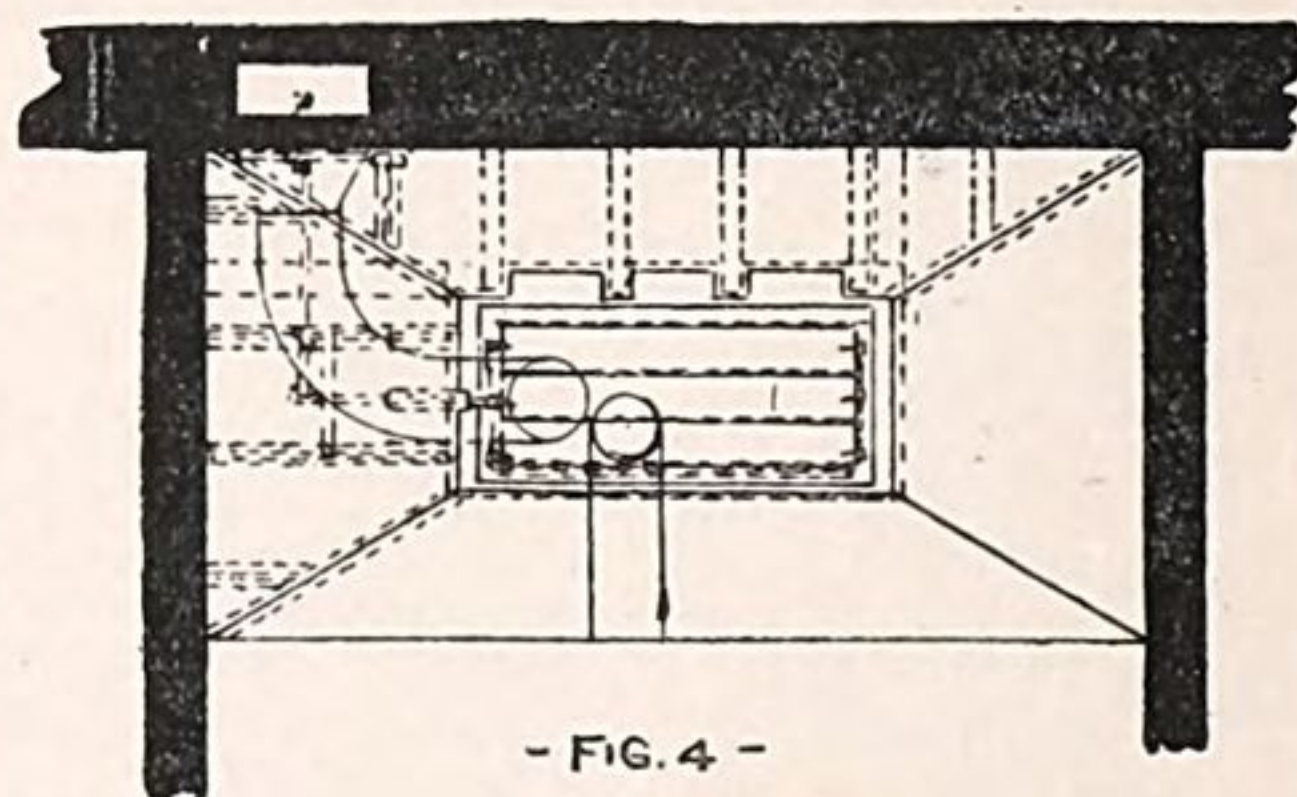
Fig. 6. Longitudinal section of commode and fireplace.

- | | | | |
|---|--------------------------------|----|----------------------------|
| V | Ventilating flue from commode. | S | Smoke flue from fireplace. |
| | | AC | Accelerating steam coil. |

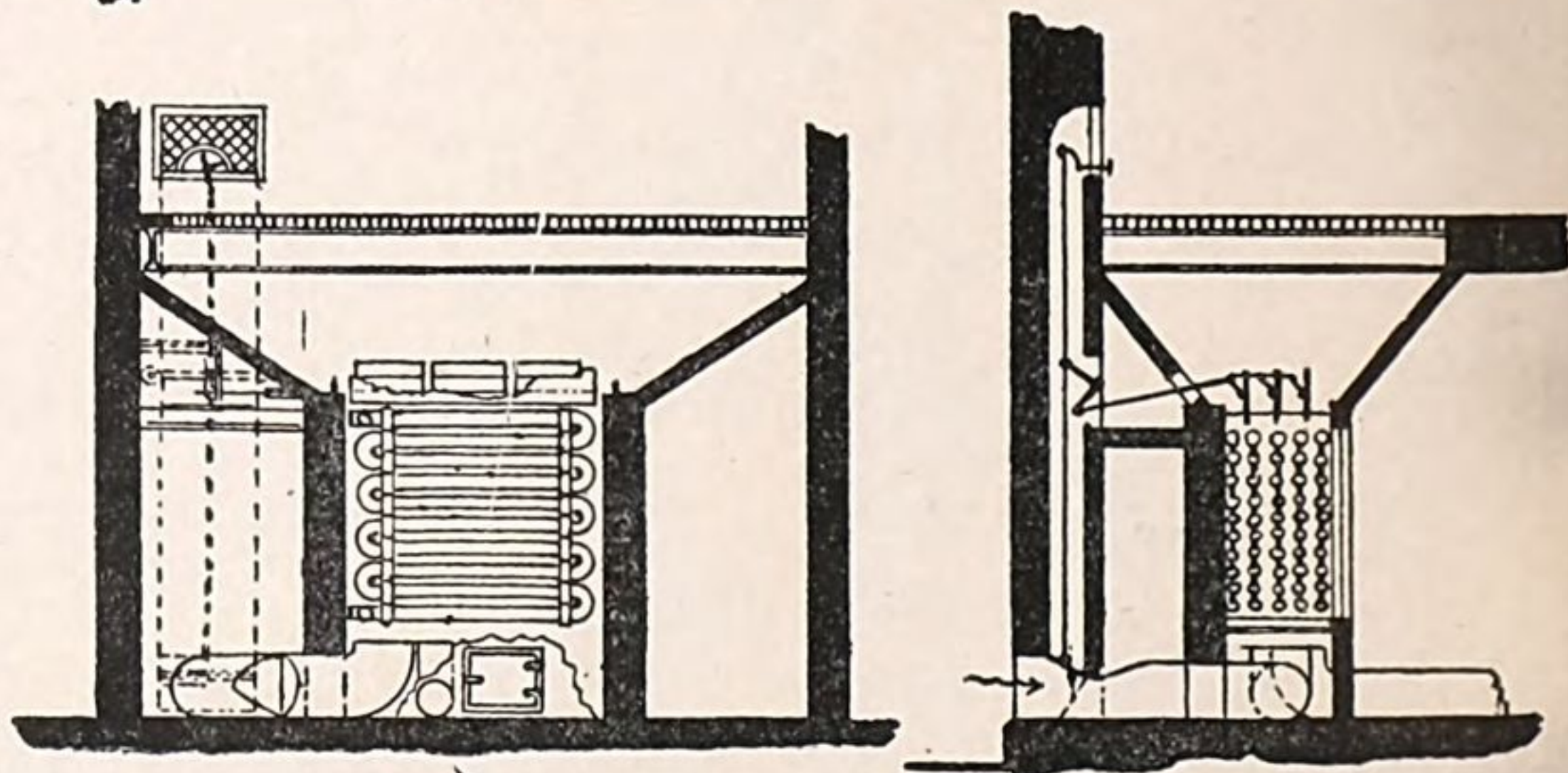
Fig. 7. Plan of fireplace and commode.

Fig. 8. Commode stand.

Fig. 9. Plan of chimney, showing vent and smoke flue.



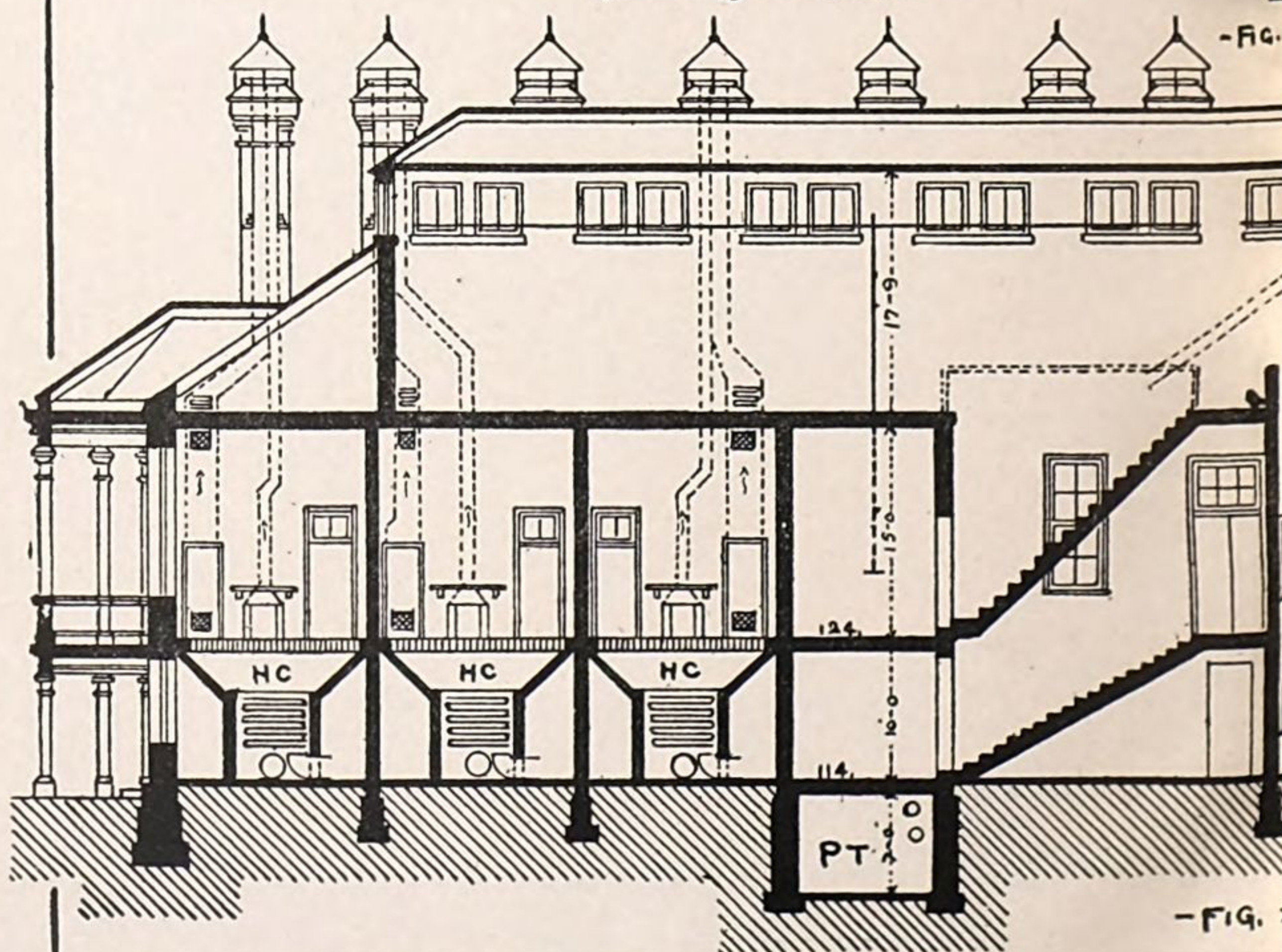
- FIG. 4 -



- FIG. 2 -

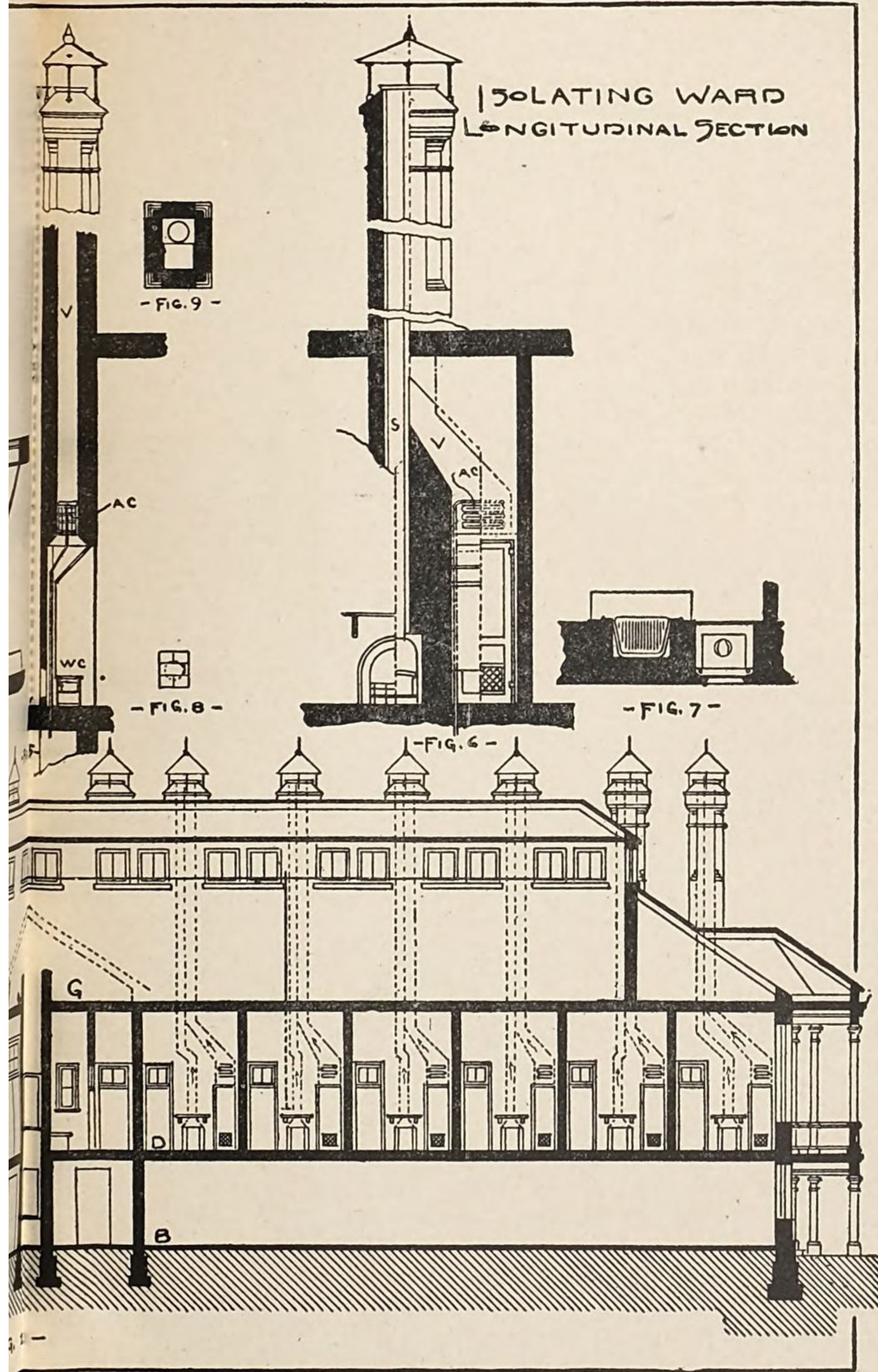
- SCALE $\frac{1}{8}$ ONE FOOT -

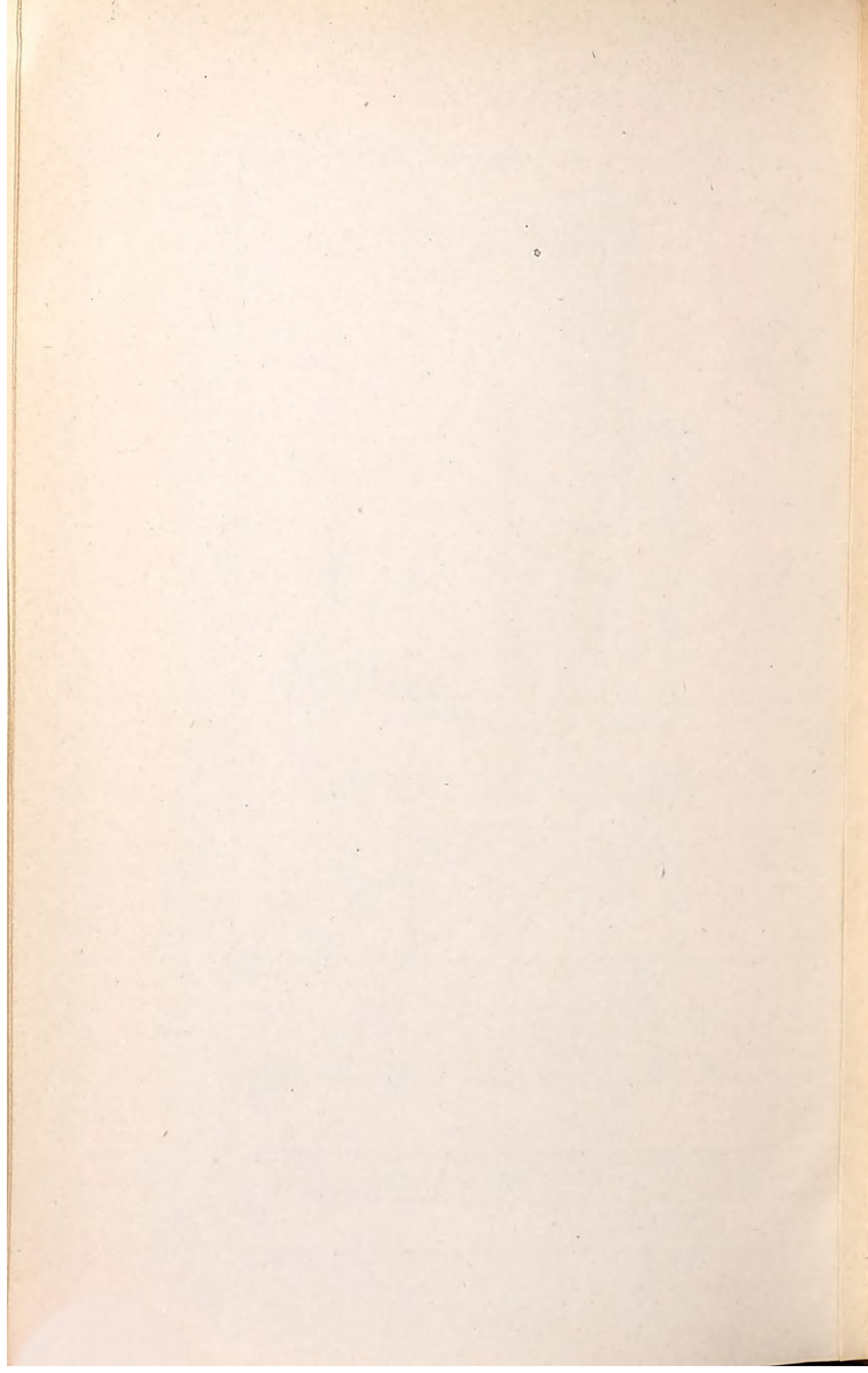
- FIG. 3 -



- FIG. 1 -

- SCALE - 20 FT. TO AN INCH -





ST. LUKE'S HOSPITAL, SOUTH BETHLEHEM, PENNSYLVANIA.

By W. H. CHANDLER, Ph. D.

[With 7 plates.]

This institution, situated near South Bethlehem, is a pavilion hospital, and was planned by the writer, D. & J. Jardine, of New York, preparing the plans in accordance with sketches and minute instructions from the writer.

The hospital grounds are about 40 acres in extent, situated on a side hill, the lay of the land making it desirable to place the pavilions for the sick in a northwest and southeast direction, that is, a line drawn lengthwise through a pavilion has that direction. The location of the other accessory buildings was determined with consideration of convenience of administration and the topography of the property.

The buildings are all of brick with stone foundations and concrete footings. With the exception of the administration building, they are of one story only.

The institution received its charter of incorporation in 1872. From 1872 to 1876 a small building was occupied as a hospital. In the latter year the present property was bought, and in 1881 the first pavilion for the sick was completed. It is a free hospital supported by voluntary contributions. In 1879, it received from the estate of Hon. Asa Packer, a bequest of \$300,000. In the midst of a large manufacturing and mining district, its resources are taxed to their utmost, and the public and the various corporations make liberal contributions to supply the annual deficiency of income necessary to its support.

THE ADMINISTRATION BUILDING.

This building was completed in 1883. It is 103 feet by 39 feet. It has two principal stories, a basement and an attic, with dormer windows, all completely finished and practically affording four stories. This building is ventilated by means of flues in the partitions, the circulation of air being accelerated by three large steam coils, placed in as many inclosed boxes, located below the large ridge ventilators. The building is heated by steam from the general boiler house. The basement floor is laid upon oak sleepers, bedded in concrete, underlaid with tarred felt and a layer of asphaltum, rendering it moisture proof. The basement is surrounded by an open area, 6 feet wide and 6 feet deep, thus affording ample light. This building contains the apartments of the hospital staff, the nurses and servants, also the office of the superintendent and the examining rooms of the physician and surgeon-in-chief.

The height of the several stories in the clear is, basement, 8 feet; first floor, 12 feet; second floor, 10½ feet, and the attic, 10 feet.

THE KITCHEN AND LAUNDRY PAVILION.

This building was erected in 1881, and is connected with the administration building by a closed basement corridor 50 feet long, 7 feet wide in the clear, and also by an open piazza surmounting the latter. This building is 68 by 65 feet, the principal story having a height of 15 and the basement 8 feet. It is ventilated by wall flues and heated by steam from the general boiler house. The cooking is done by coal. The laundry is supplied by steam washing, drying, and mangling machinery. A portion of the basement is occupied by storerooms, the balance containing the steam-engine and the washing cylinders and centrifugal drier.

THE MEN'S PAVILION.

This was completed in 1881, and contains two wards of twelve beds each, dining, clothes, bath, and toilet rooms and solarium, similar to those in the childrens pavilion. It is connected with the kitchen and laundry pavilion by a closed basement corridor, surmounted by an open piazza. This building is connected with the women's pavilion and the operation pavilion by closed basement as well as a closed corridor on the principal floor.

THE OPERATION PAVILION.

This was completed in 1881, and is 68 by 31 feet. It contains the operation, examination, and apothecary's rooms. The outdoor patients also receive here daily gratuitous consultations. The operation room is 32 feet 6 inches by 25 feet 8 inches, with raised seats for students, and a skylight with northern exposure. The apothecary's room is 22 feet 6 inches by 17 feet, the examining room for outdoor patients 10 feet by 8 feet 6 inches, and the waiting room for the same patients 10 feet by 13 feet 8 inches. The height of these last three is 11 feet; of the operation room, 20 feet 6 inches. The main hallway from the main entrance, which is in this building, is 8 feet wide.

THE WOMEN'S PAVILION.

This was erected in 1885, by Robert Lockhart, in memory of his wife, Mrs. Annie P. Lockhart. It contains a ward of twelve beds, six private rooms, dining, clothes, bath, toilet, and operation rooms and a solarium, similar to those of the children's pavilion.

THE CHILDREN'S PAVILION.

This was erected in 1890, in memory of Merit Abbott Wilbur, by his parents, Elisha P. and Stella M. Wilbur. It contains a ward of twelve beds, five private rooms, dining, clothes, bath, toilet, and operation rooms, and a solarium. It is connected with the men's

and women's pavilion by an open basement corridor, surmounted by an open piazza. The basement corridor has side walls of stone 6 feet high, lined with brick. Between these and the bottom of the piazza is an open space $2\frac{1}{4}$ feet high, through which the air has free access. The floor is covered with concrete. By this means communication can be had through the basement of the men's pavilion from the kitchen and laundry pavilion, with some protection from the weather, and at the same time isolation of this line of pavilion is effected.

The dimensions of the wards in the clear are 49 feet 6 inches by 26 feet 8 inches, the side walls are 14 feet high, and the iron ceilings, at the top of the arch, 6 feet higher, or 20 feet from the floor. These wards contain twelve beds, with an air allowance of 2,045 cubic feet per bed. It was thought better to have wards of twelve beds in preference to those of double the area, as is usual, as in the smaller wards the personal influence of the patients upon each other may, perhaps, be less effective on the nerves or sensibilities.

The dining and clothes rooms are each 17 feet 9 inches by 12 feet 10 inches and 14 feet in height. Lifts for food and clothing connect these with the basement. The clothes room is provided with closets for bedding, etc., and the dining room with pantry closet and steam plate warmer.

The children's pavilion is provided with five private rooms 10 feet 3 inches wide, and in length ranging from 10 feet 8 inches to 13 feet 10 inches. The height is also 14 feet. All the other rooms have this height. The hall between the private rooms is 5 feet 2 inches wide. The private bathroom is 8 feet 4 inches by 10 feet 3 inches; the private toilet room 5 feet by 10 feet 3 inches. The bathroom for ward patients is 12 feet 4 inches by 8 feet 4 inches, and the two toilet rooms each 6 feet by 8 feet 4 inches.

The operation room is 21 feet 2 inches by 13 feet 10 inches. This room has a plastered ceiling and solid double doors to deaden the sound. The floor is of encaustic tiles and the wainscoting 4 feet high of glazed tiles.

The toilet and bath rooms and the vestibule have tiled floors and the bathrooms also wainscoting of glazed tiles.

The solarium is 27 feet 4 inches by 28 feet, with glazed skylight.

All the walls and the ceilings are painted with English silicate paint, sold by Jennings, Liberty street, New York, free from lead, which is not considered desirable. The solarium ceiling is of yellow pine and is finished with shellac varnish.

The pavilions for the sick are placed 50 feet apart longitudinally; the pairs of pavilions are placed 100 feet apart, and, owing to the general slope of the land, have an increased elevation of 11 feet. Considering this lay of the land, a survey determined that, in order that during the shortest day of the year, the rays of the sun glancing over the roof peak of one pair of pavilions should strike the

foundations of the next lower pair at the surface of the ground, the distance between any two rows would have to be about 60 feet. It was decided to increase this distance to 100 feet, so as to increase the influence of the sunlight and the free access of air. The method of connecting the pavilions is described under the head of the children's pavilion.

In future the pairs of pavilions as well as each pavilion will be isolated in the manner there given.

The pavilions for the sick all have the same exterior dimensions, whether they are subdivided into two large wards or contain some private rooms. The foundations are of stone, with concrete footings, lined with one course of brick, a layer of asphaltum being interposed between the brick and the stone. This layer is as thin as practicable, about 1 inch. It is poured in a melted condition as rapidly as the lining is built. Upon the stone foundations asphaltum is poured to prevent the access of moisture. The brick walls are laid upon this latter. These walls consist of two 8-inch walls with a 4-inch space between. The two walls are held together by iron straps distributed at proper intervals, thus avoiding the transmission of moisture which binders of brick would permit. The basement floors are prepared by laying down two courses of tarred felt, covering this with a layer of asphaltum 1 inch thick and finishing with a concrete and cement floor. A basement thus prepared is moisture proof from the soil.

The brick walls are finished on the interior with a thin, rough coat and hard finish. The inner partitions are made of porous brick, finished in the same manner. The ceilings are made of corrugated sheet iron, galvanized on both sides, with 1-inch corrugations. This is painted on both sides. All the corners and angles within the building are rounded, so as to avoid, as much as possible, places for the collection of dirt beyond the care of the careless housemaid. The woodwork, doors, and windows are made as plain as possible, with plain beveled moldings. The windows and the doors, with the exception of the toilet and operation room doors, are provided with glazed transom lights, hung on pivots. The doors, with the same exceptions, are glazed with ribbed glass, in order that the halls may be well lighted. Outer slatted blinds are attached to all the windows, save those of the solarium.

The floors are made double, the lower of hemlock, laid diagonally; the upper of yellow pine, longitudinally, 2½-inch boards, a layer of sheathing paper being laid between the two courses.

The skylight of the solarium is of Hayes's make, of New York, and has never given any trouble by leaking water.

The water supply, steam, and drainage pipes all are brought in above the floor of the basement.

The ventilation is effected by tin flues placed in the outer walls

between the windows, and continued to the ventilations at the peak of the roof. Within these flues is a double iron 1-inch steam pipe, extending 14 feet in height, through which steam circulates, thus warming the air in the flue and accelerating the current. A register, placed 6 inches above the floor in the side walls, is used for winter ventilation, and a similar one 6 inches below the ceiling for use in summer.

The heating is effected by steam, both the indirect and the direct systems being used in every room. With the indirect system, the air from outside passes through galvanized iron conductors over steam coils placed in the basement, inclosed in boxes of the same material, and, being warmed, passes into the rooms through registers in the floors. This assures a supply of warm, fresh air. The direct system is used as accessory to the indirect, steam radiators being placed in each room, so that in windy or severe weather a certainty of heat may be assured.

THE BOILER HOUSE.

This was completed in 1885, and supplies the steam for heating all the buildings. It is 50 by 25 feet and 11 feet to the girders, but clear to the peak, with ventilator in the latter, and stack 75 feet high. A stone duct, 3 feet by 4 feet 6 inches, under ground, connects the boiler house with the women's pavilion, and a similar duct connects the latter with the children's pavilion, through which the main steam pipes are led. These ducts are closed with masonry around the pipes at the walls of the building, so that no gases or odors may be transmitted from one building to another. Access is had to the ducts by manholes placed outside.

There are three tubular boilers, one of which is run at a pressure sufficient to drive the engine in the laundry pavilion. The boiler house will accommodate three additional boilers, when necessary.

The hospital has at present fifty-nine beds. If it is completed in accordance with the accompanying plans, the five pavilions, not yet built, to contain each two wards of twelve beds each. The total number of beds will be one hundred and eighty.

The total cost of the building will be \$250,000, or \$1,400 per bed. In this amount is included the cost of increased accommodation for the additional nurses and servants.

Allowance of air space per bed.

Hospital.	Cubic feet.
Antwerp Hospital	1,895
Berlin City Hospital	2,028
Johns Hopkins Octagon Hospital	1,761
Johns Hopkins Common Hospital.....	1,769
St. Luke's Hospital.....	2,045

Cost.

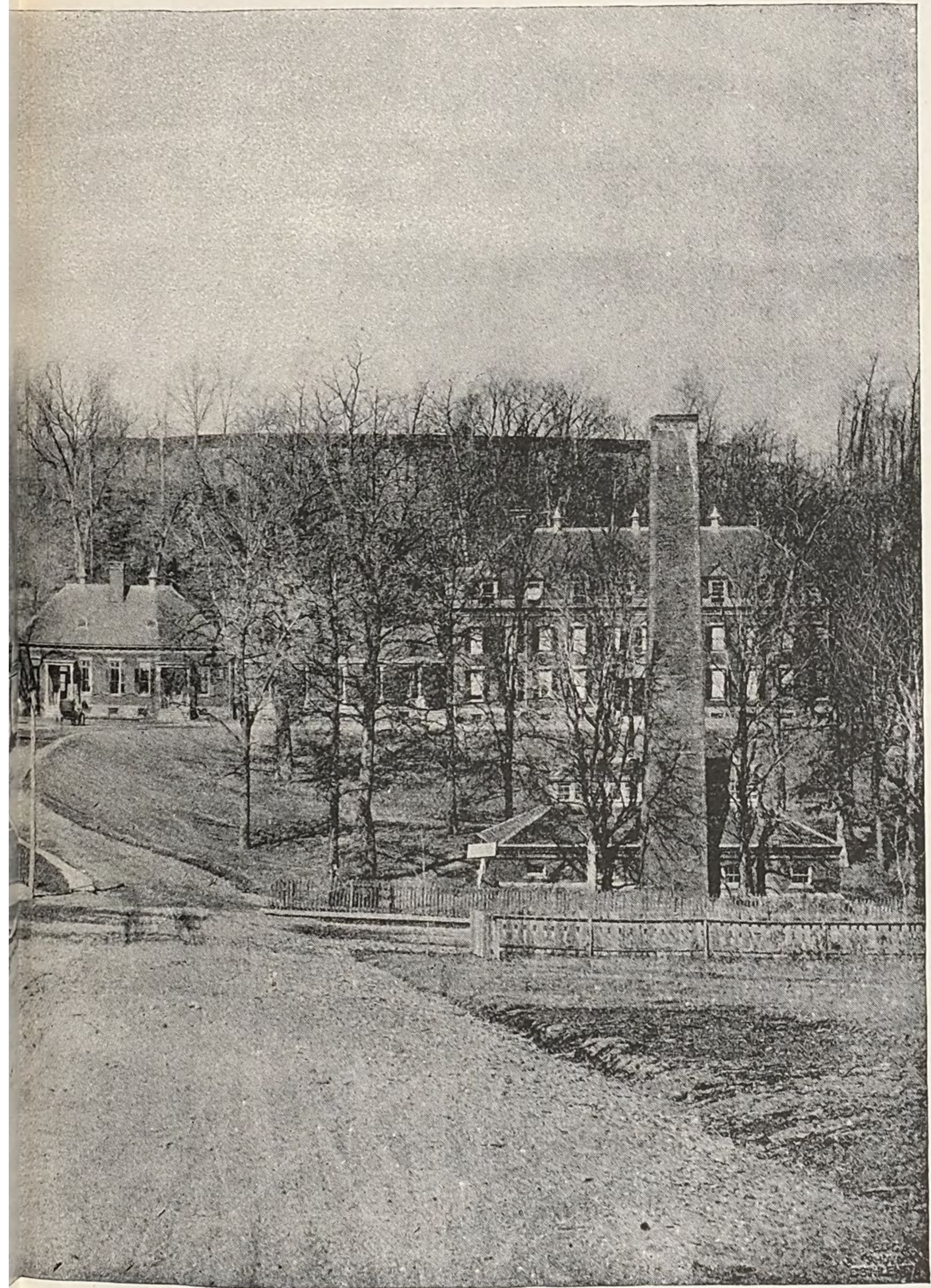
Hospital.	Total.	Number of beds.	Per bed.	Number of acres of land.
Antwerp Hospital.	\$641,877	500	\$1,284	9.51
Berlin City Hospital	1,054,315	600	1,757	25.29
St. Luke's Hospital.....	250,000	180	1,400	40.00
Johns Hopkins Hospital *.....	1,610,405	238	6,724	14.00

* When completed according to the original plan. Johns Hopkins Hospital will contain four hundred beds. Allowing \$200,000 as the cost of five pavilions for the additional beds, the total cost would be \$1,810,405, equal to \$4,526 per bed.

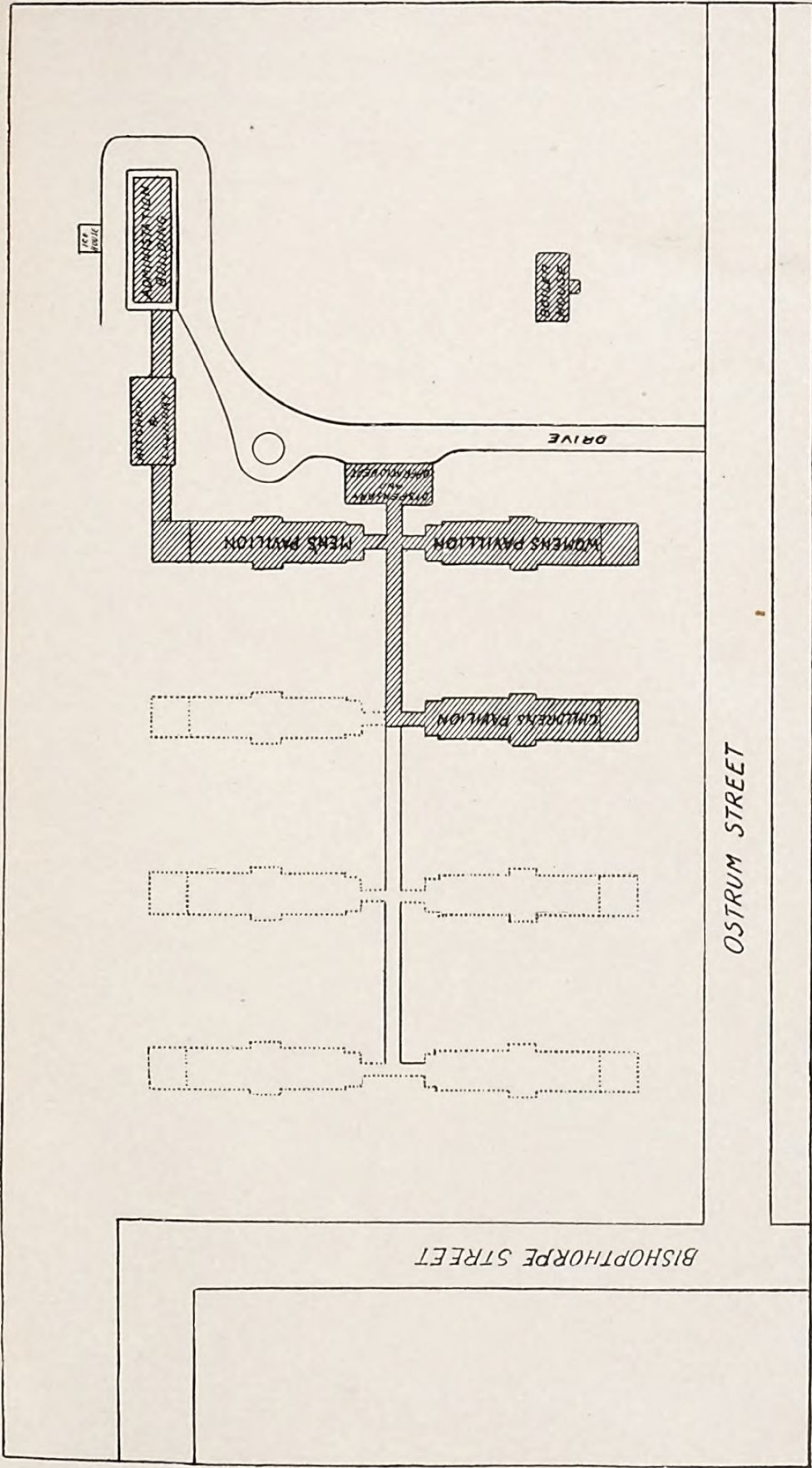
This cost does not include the cost of the land.



ST. LUKE'S HOSPITAL, SOUTH BETHLEH



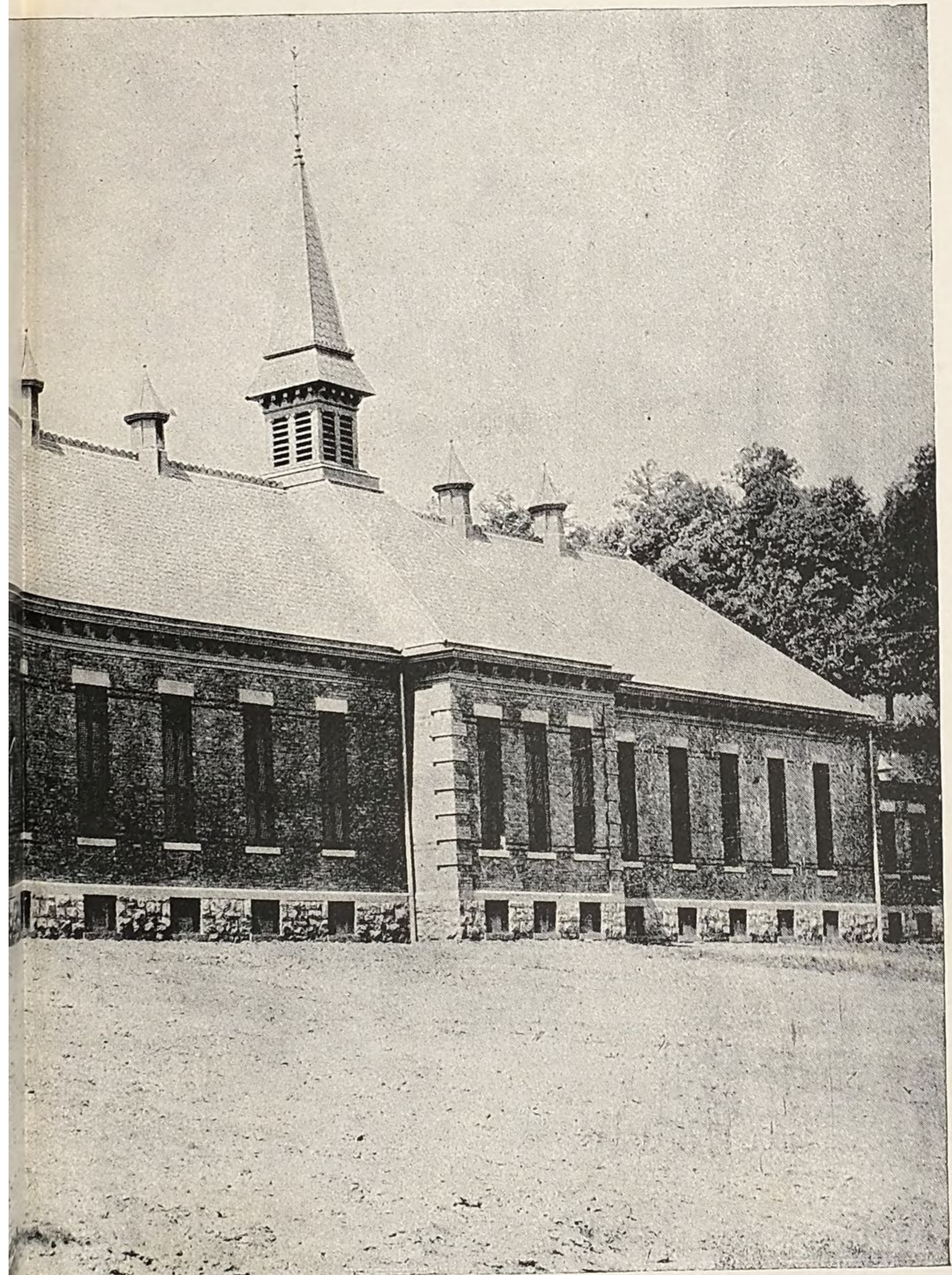
ALBANY, PENNSYLVANIA—FRONT VIEW.



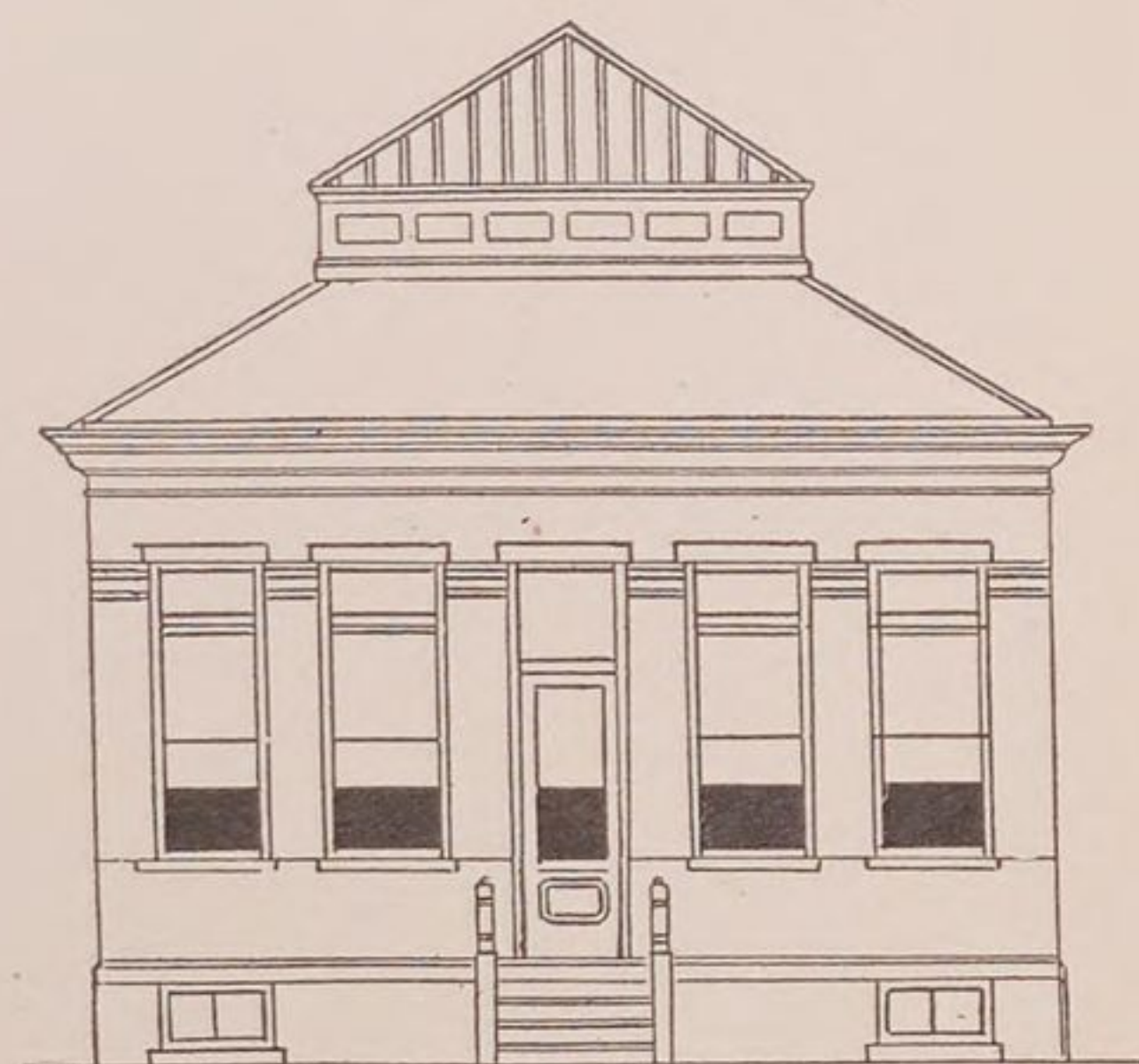
ST. LUKE'S HOSPITAL—PLAN.



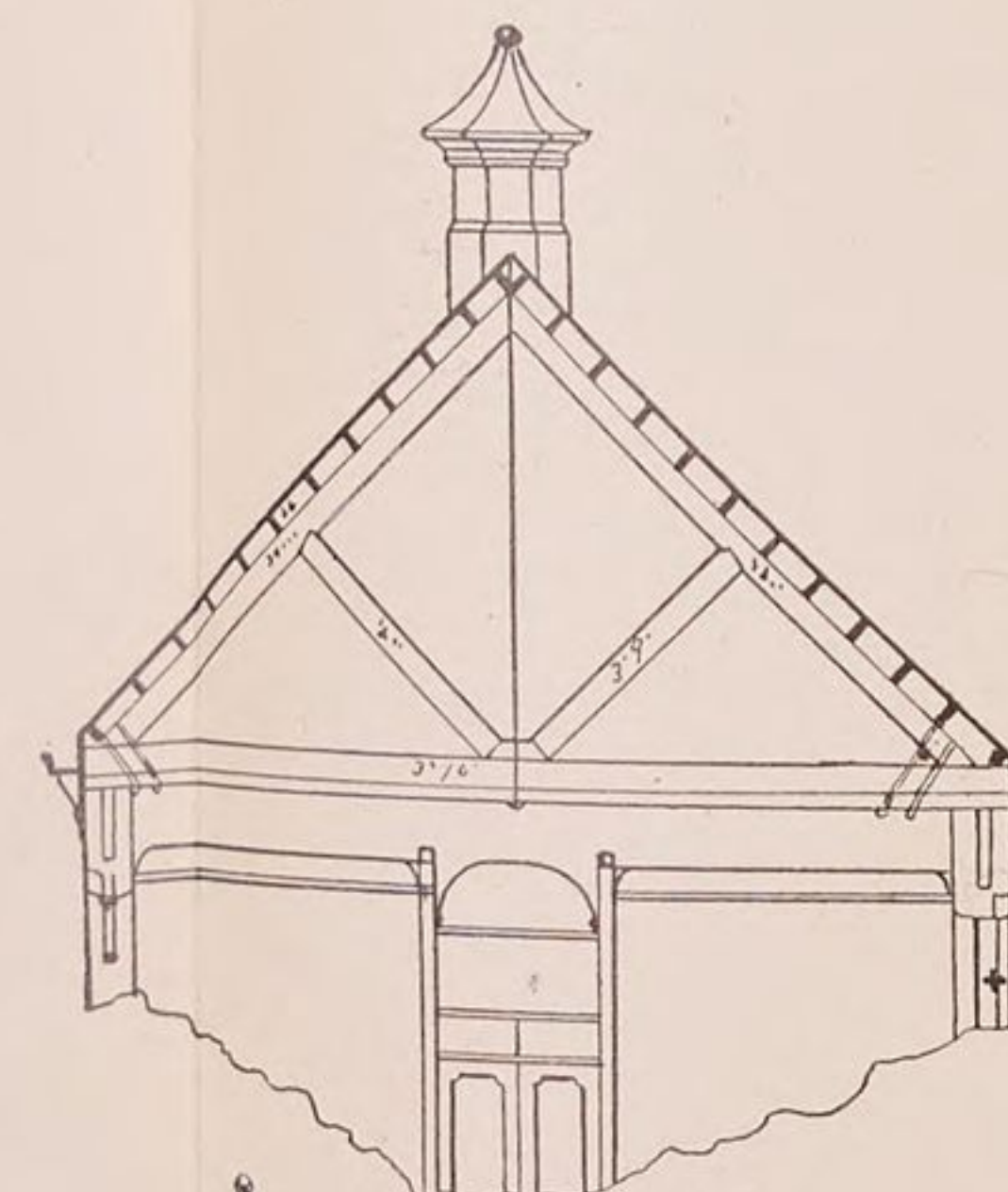
ST. LUKE'S HOSPITAL



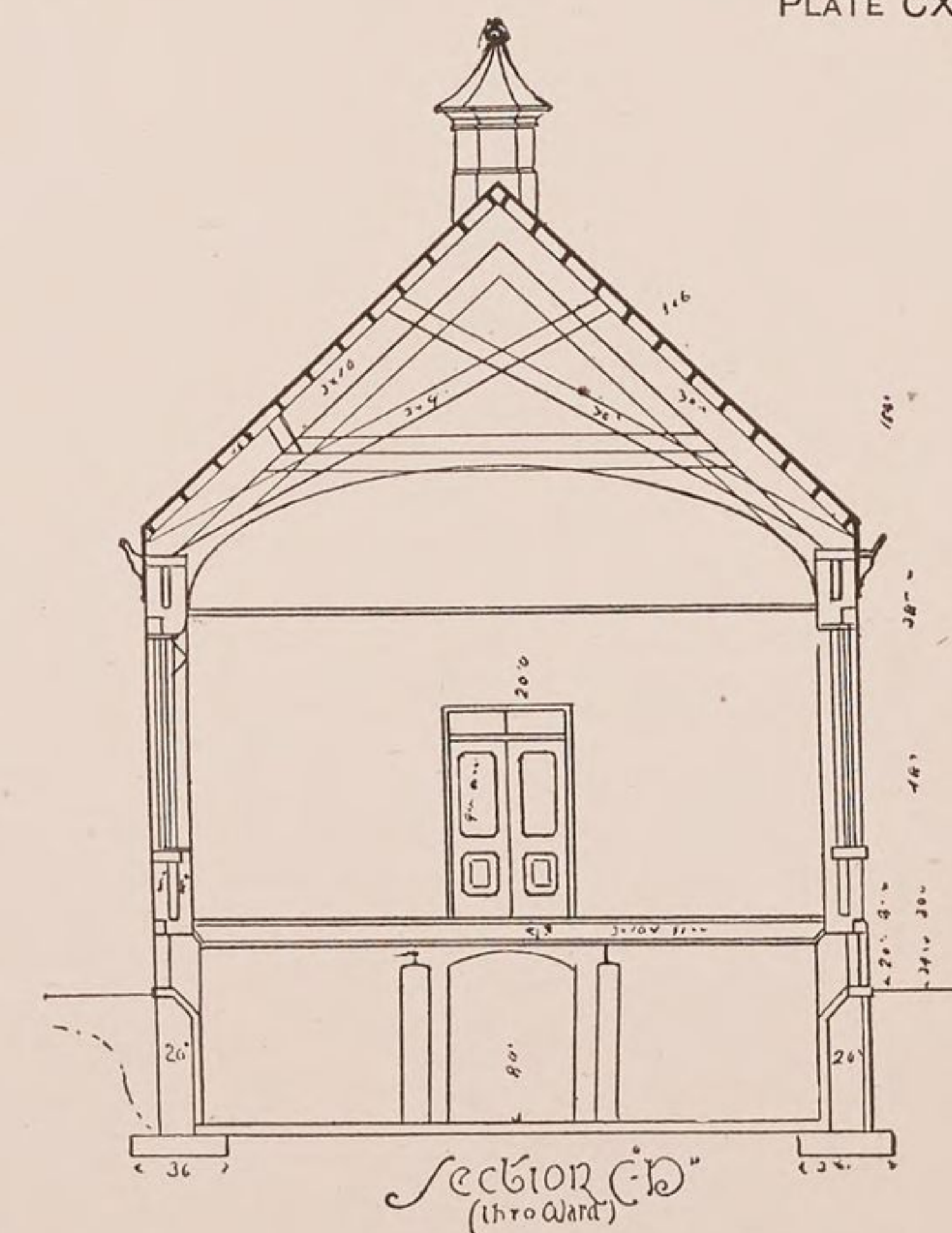
CHILDREN'S PAVILION.



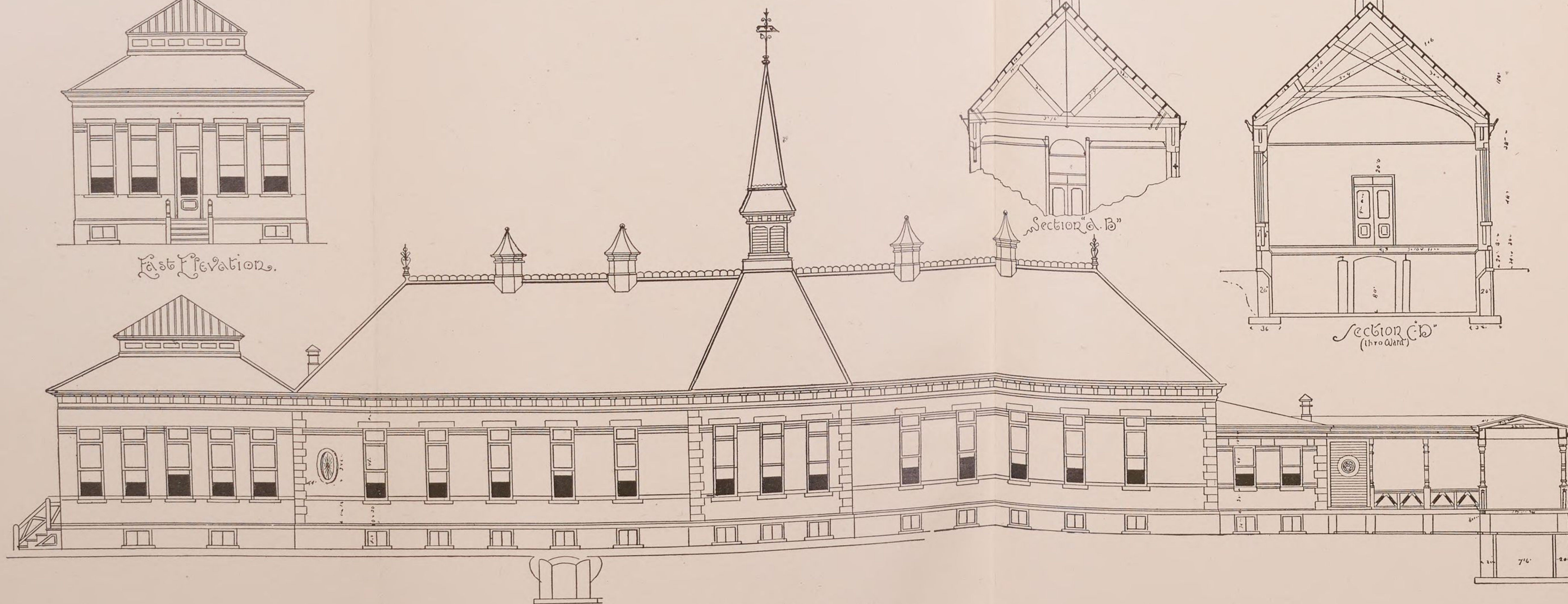
East Elevation.



Section "A. B."

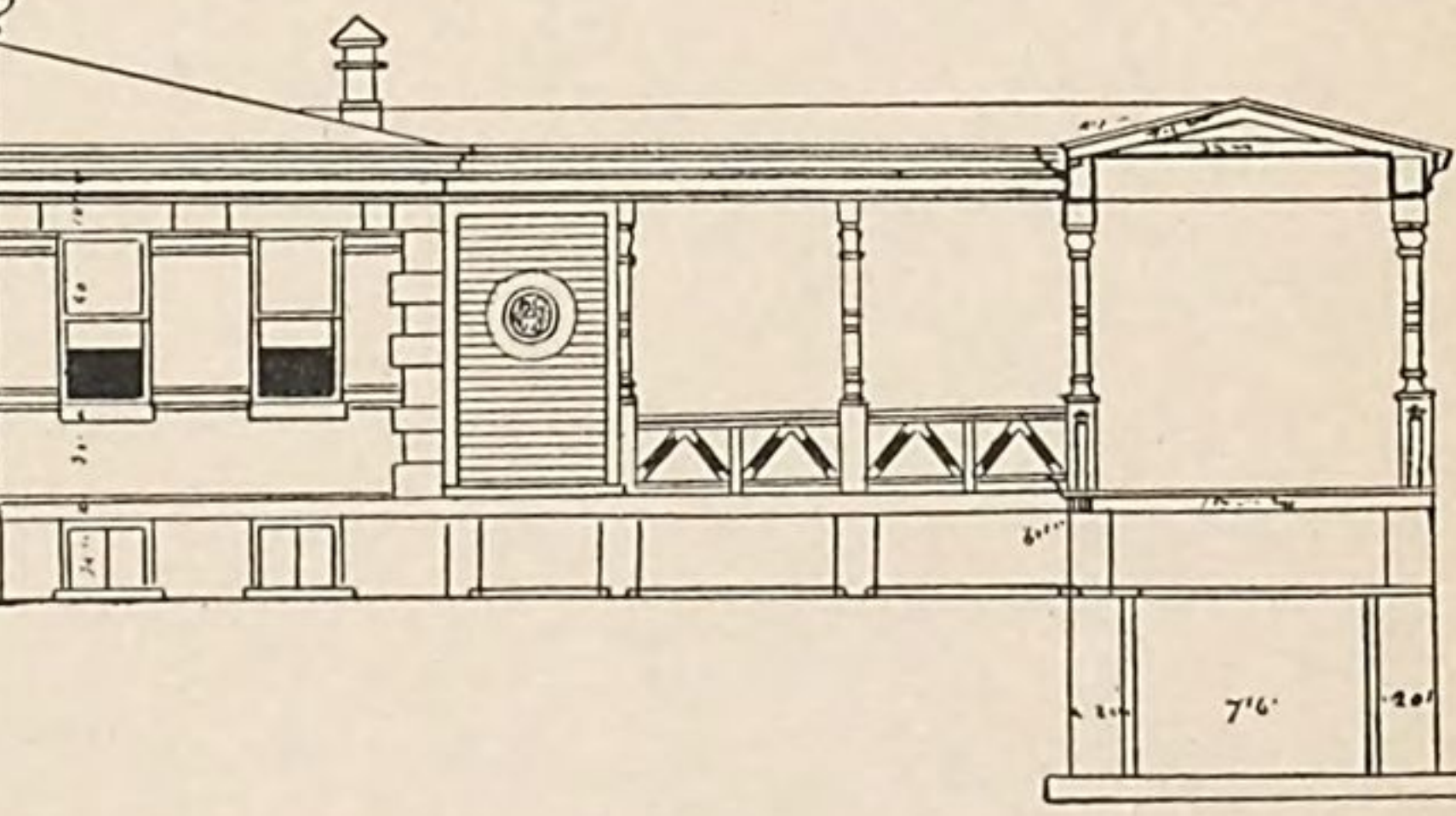
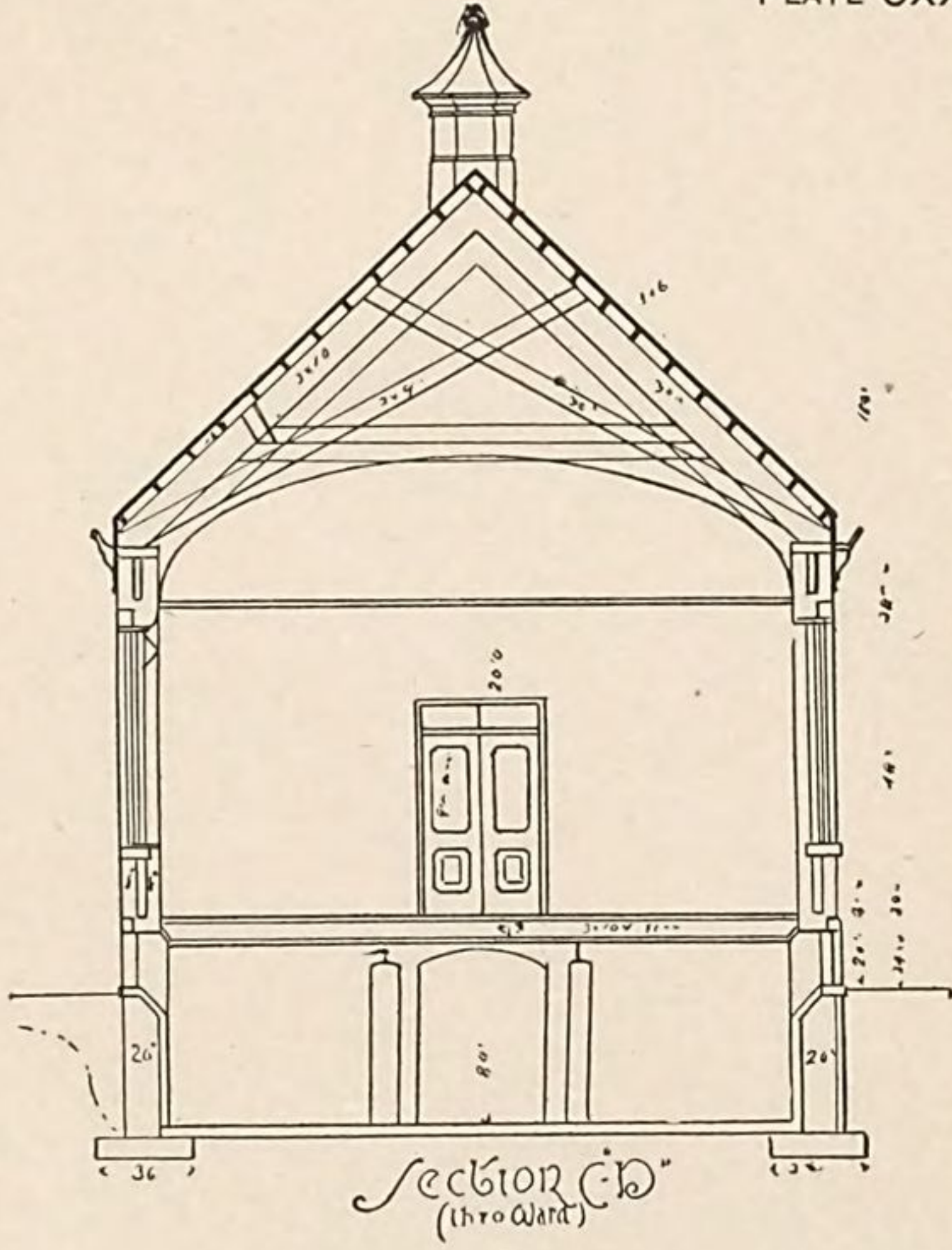
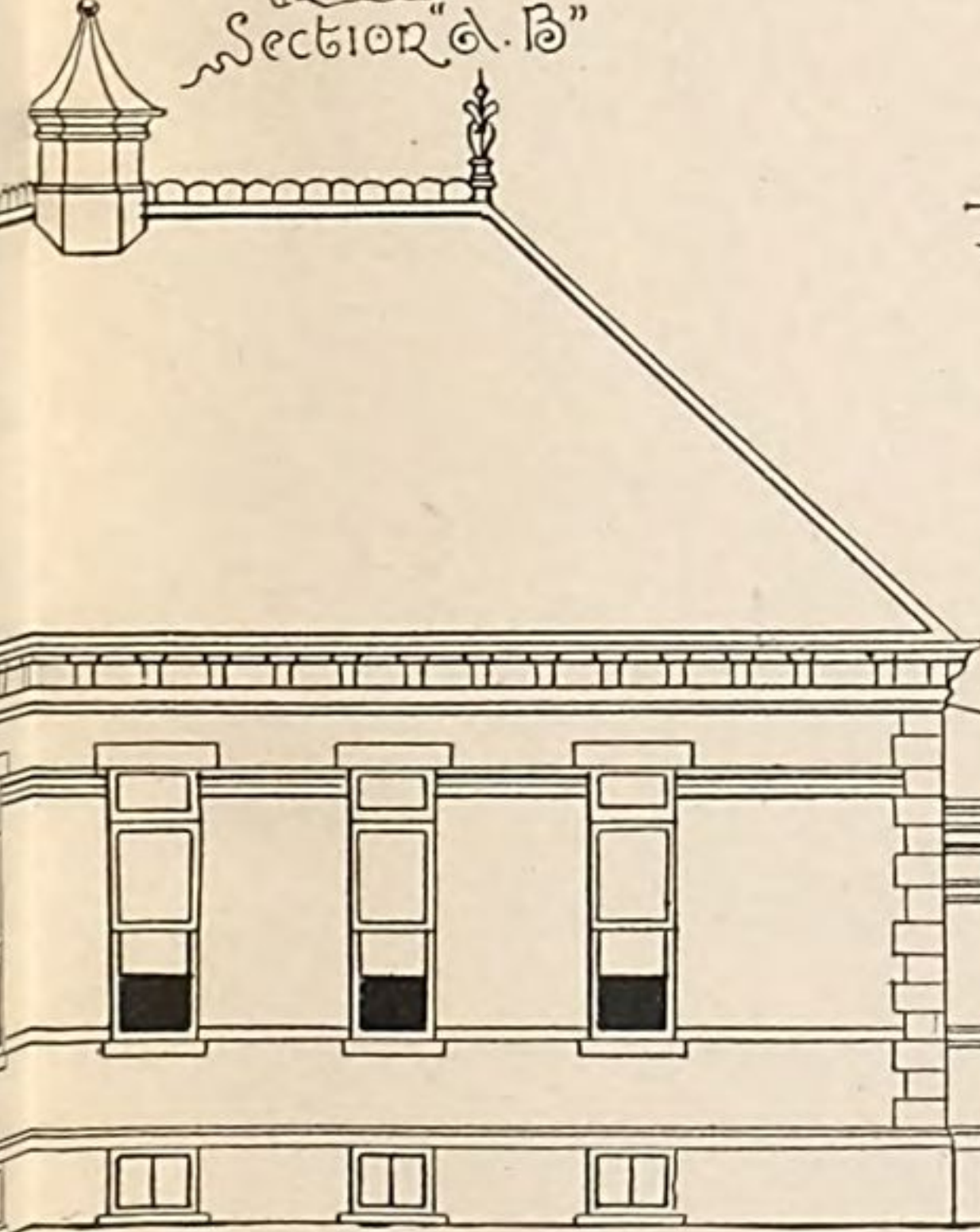
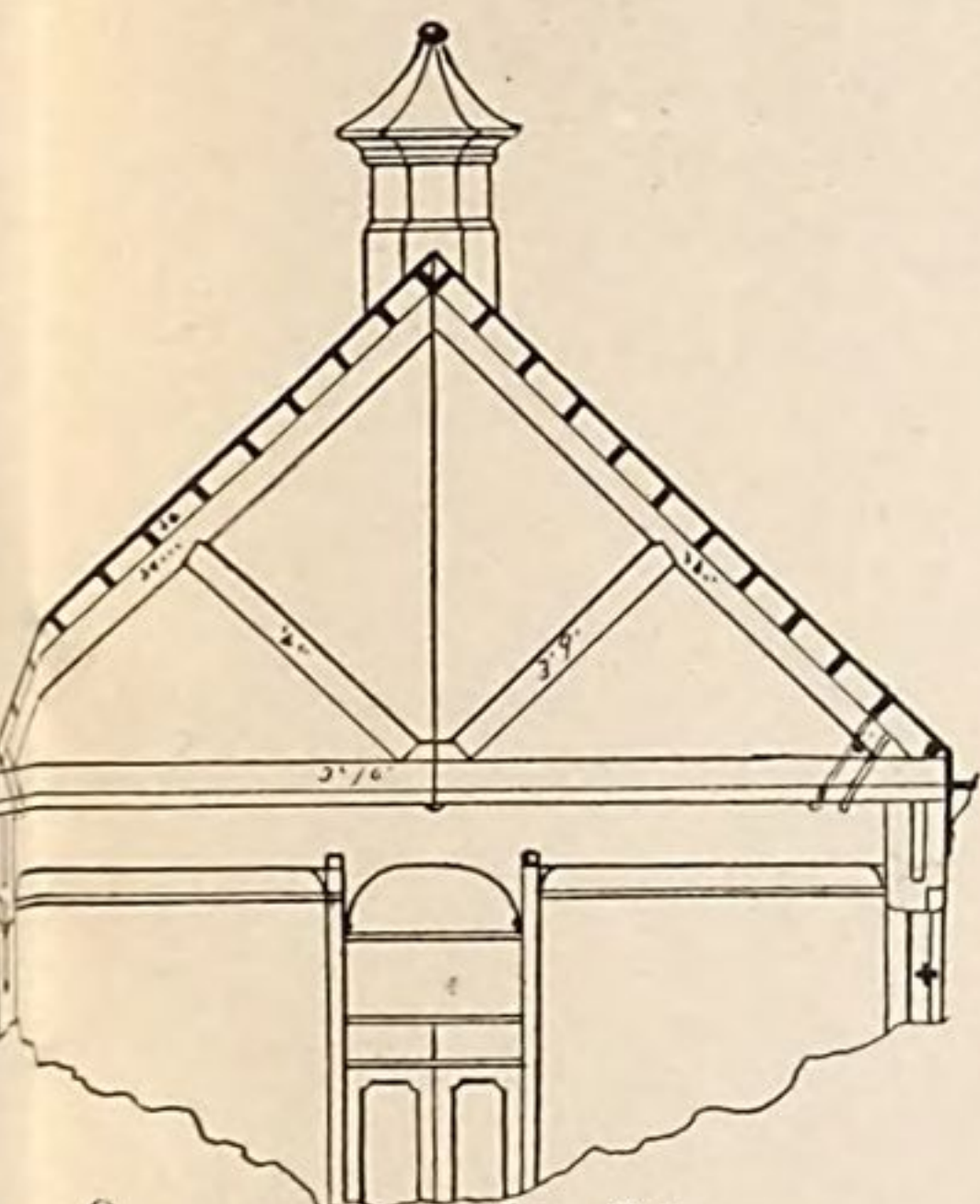


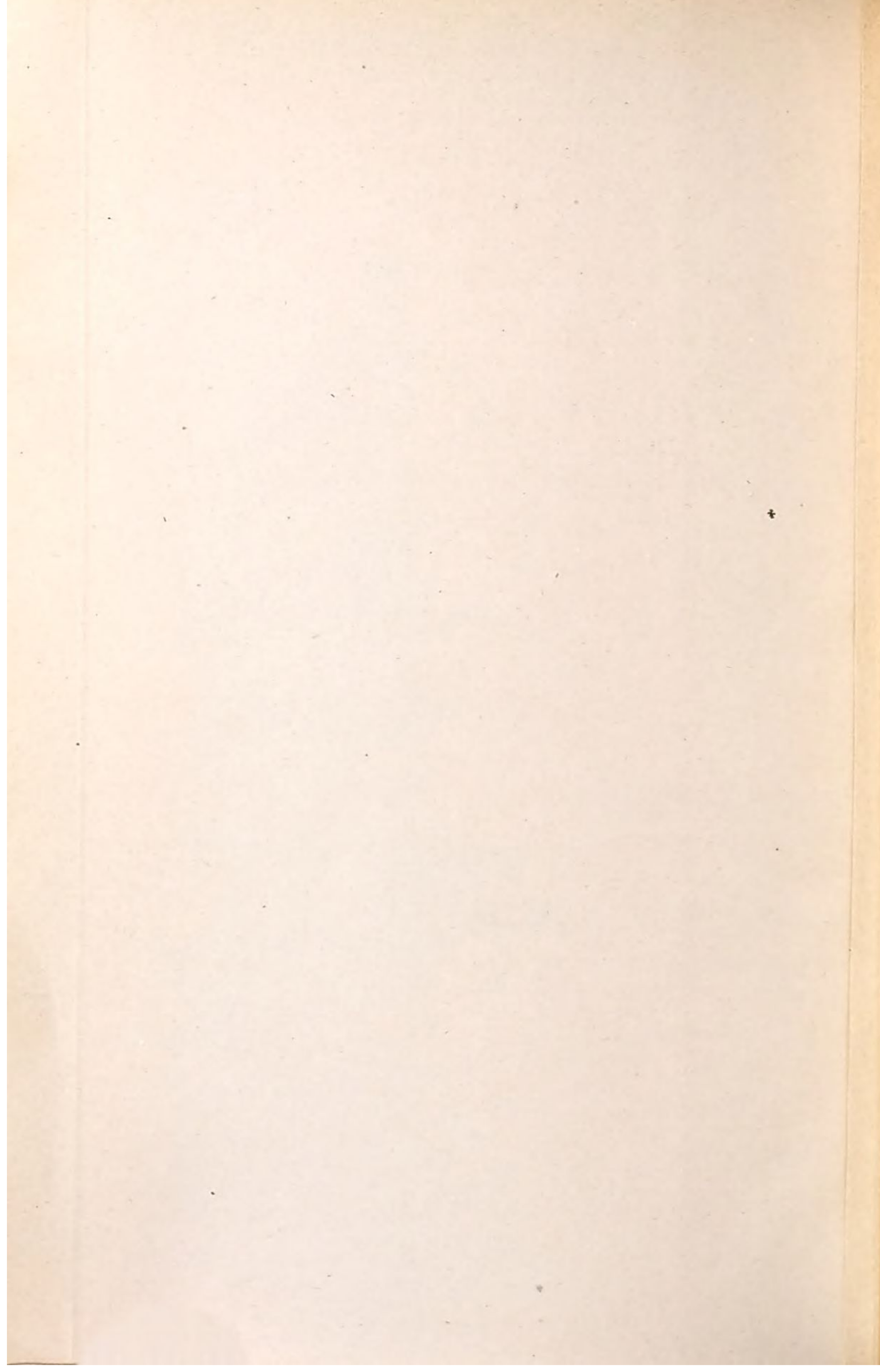
Section "C. D."
(thru Ward)

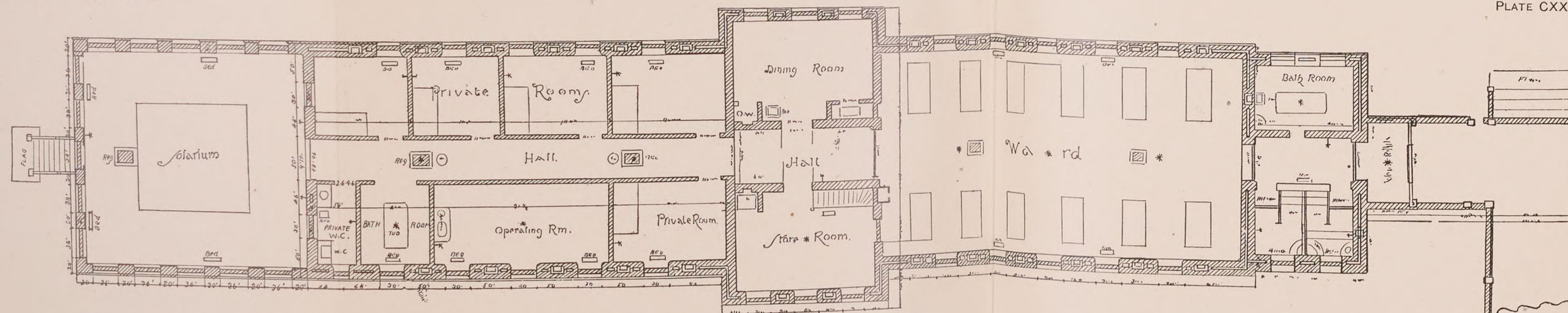


North Elevation.

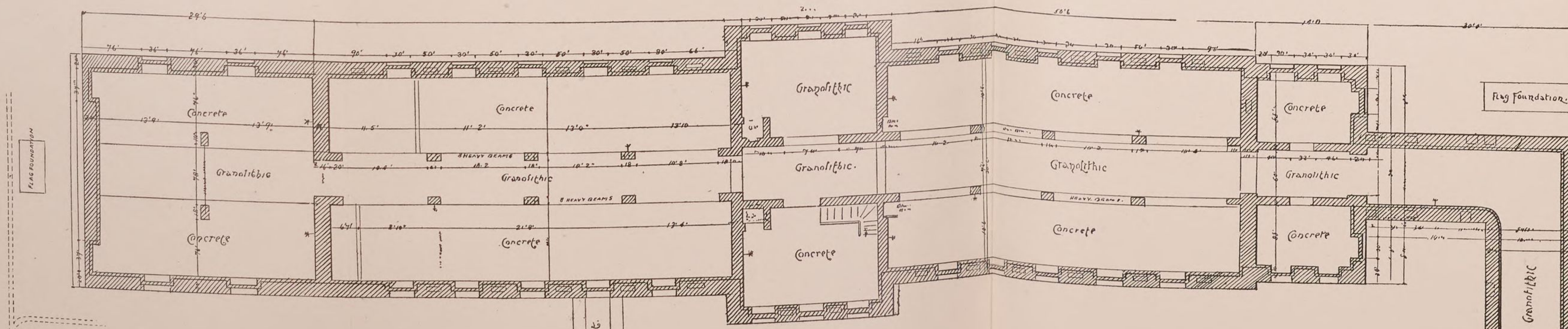
ST. LUKE'S HOSPITAL—CHILDREN'S PAVILION.







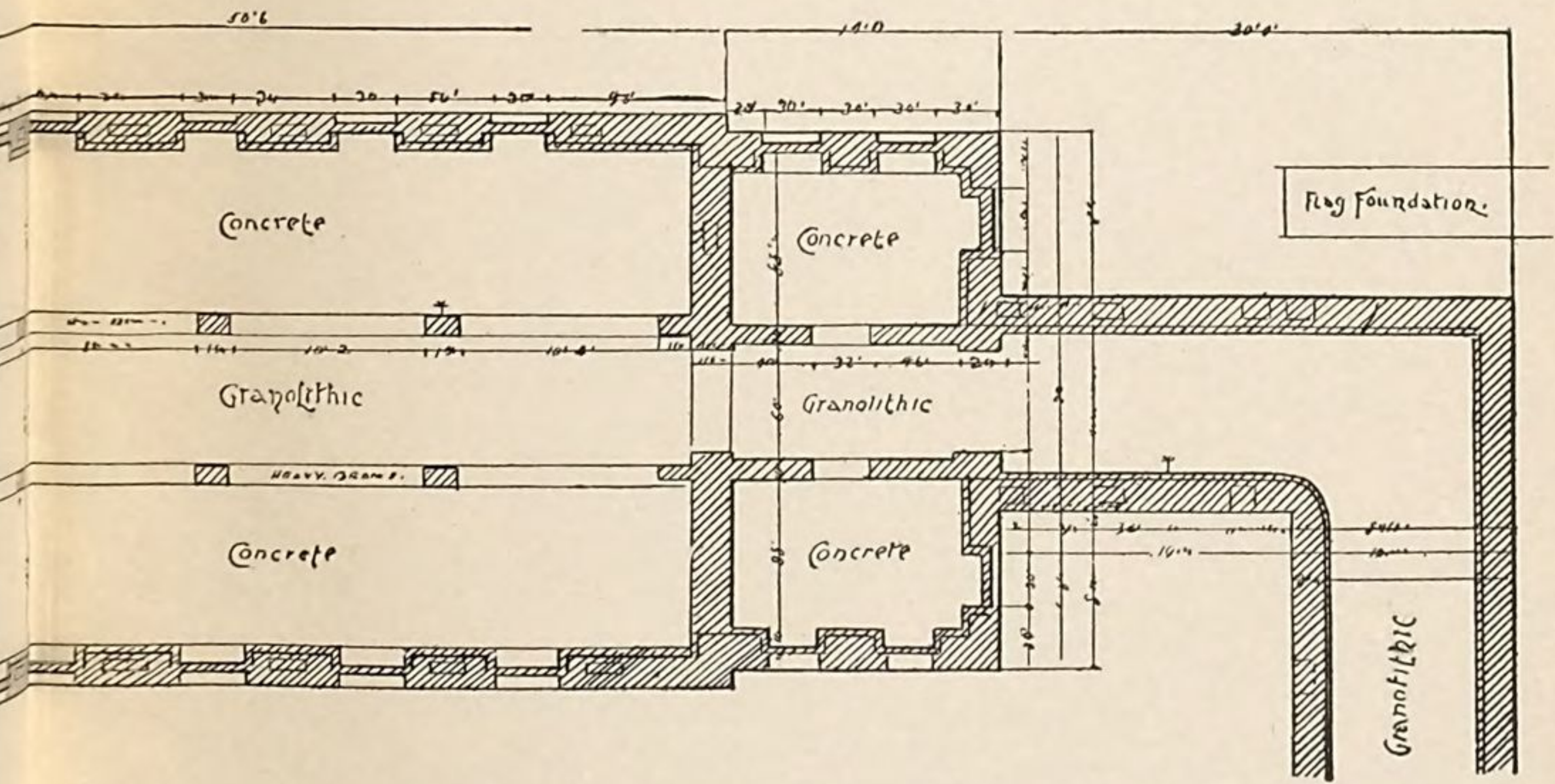
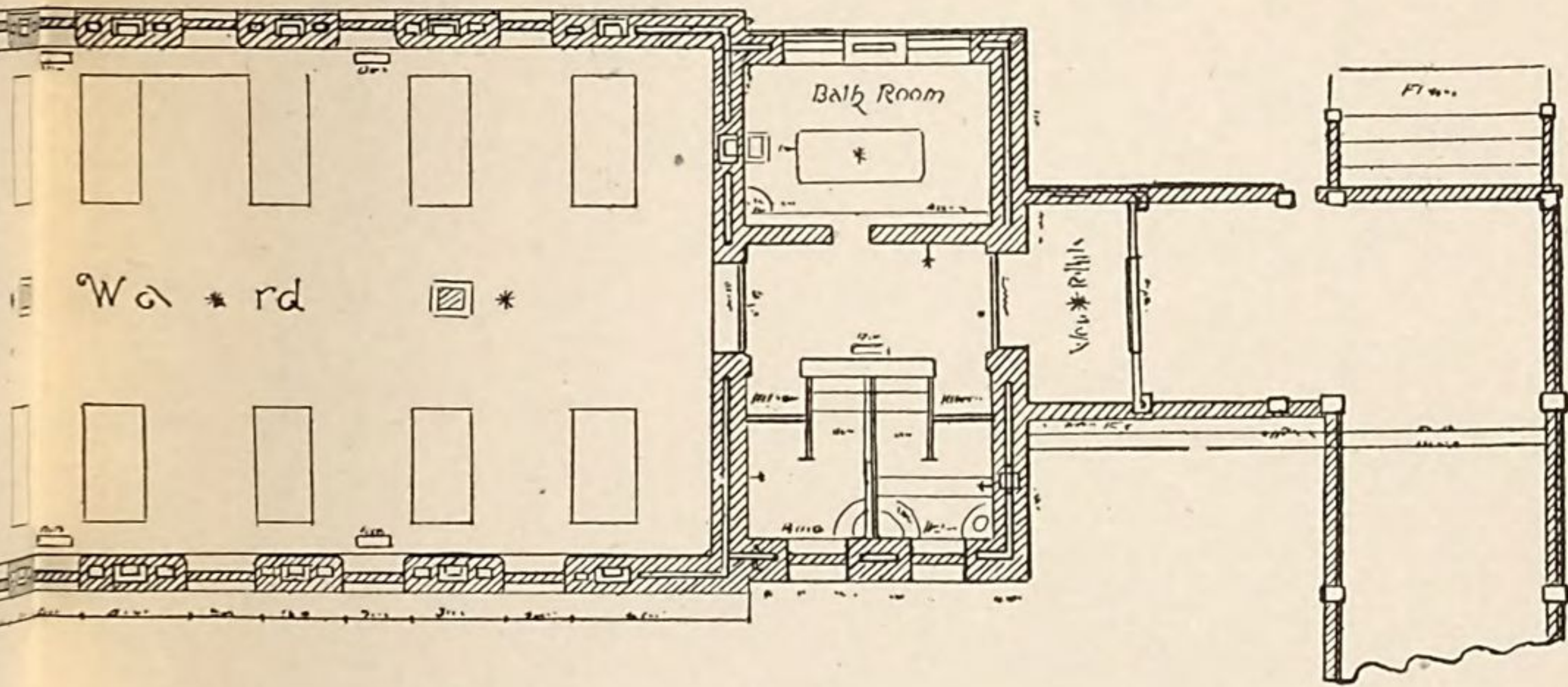
Principal Story.



Basement.

ST. LUKE'S HOSPITAL—CHILDREN'S PAVILION.

PLATE CXXXIX.

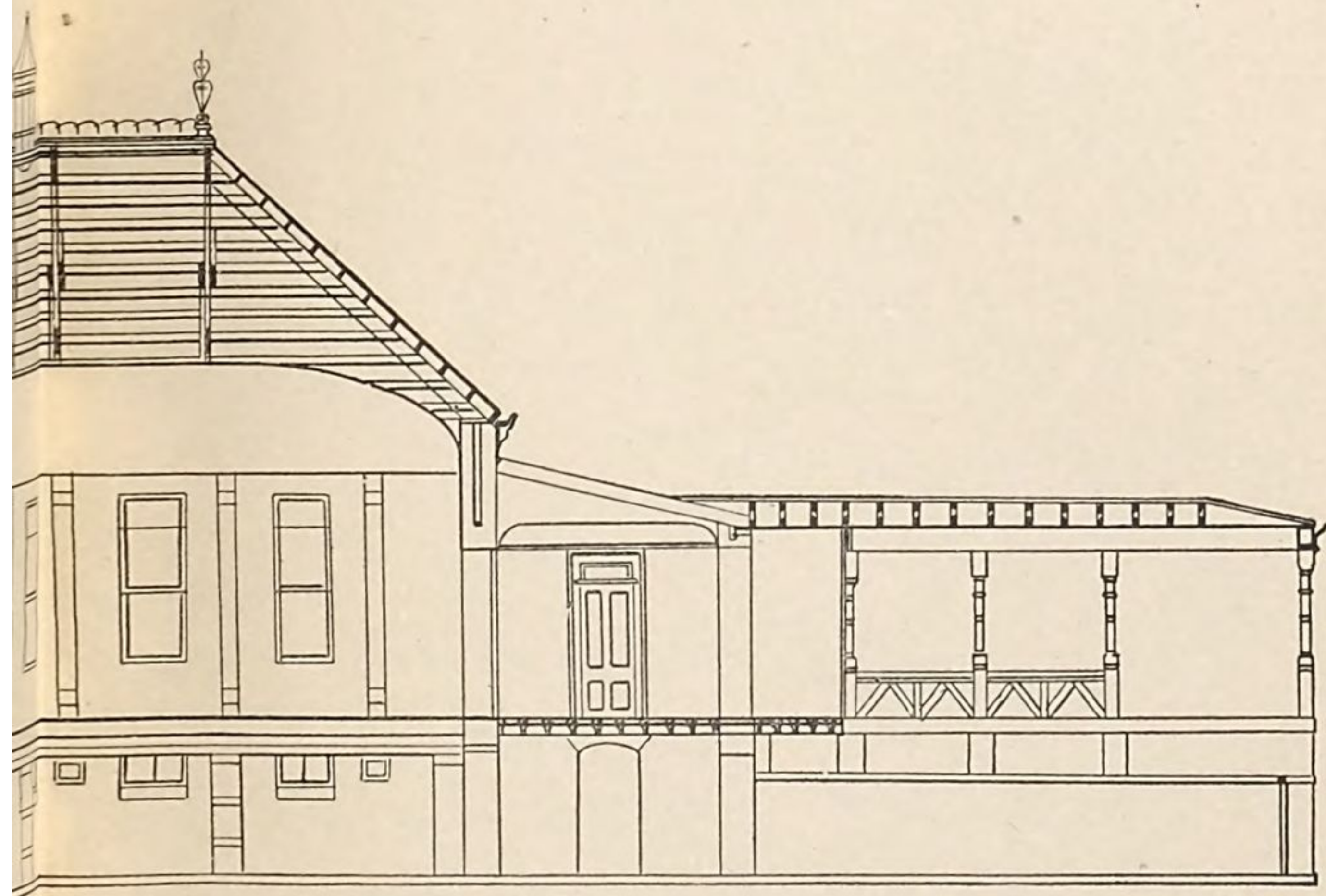


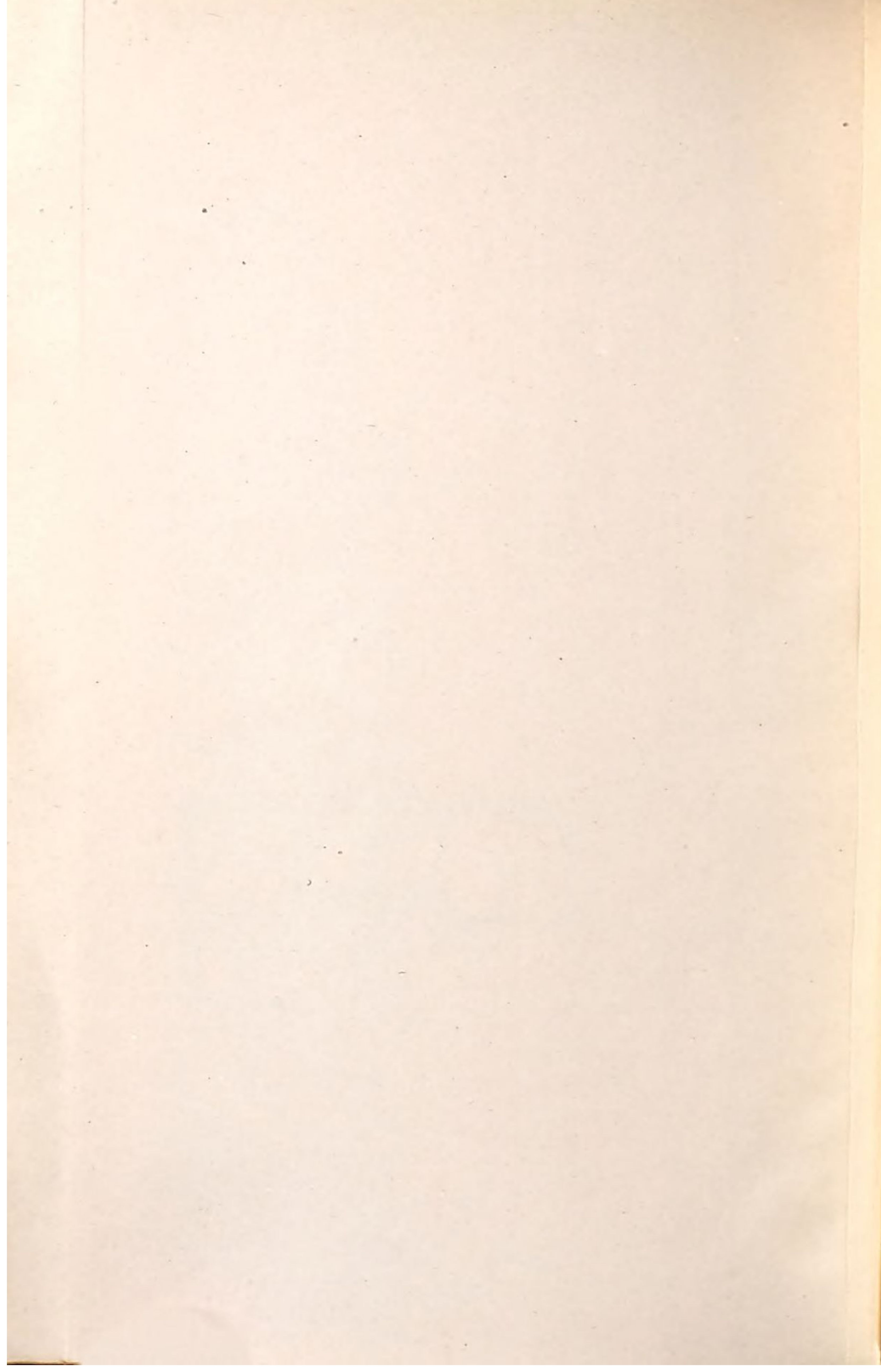


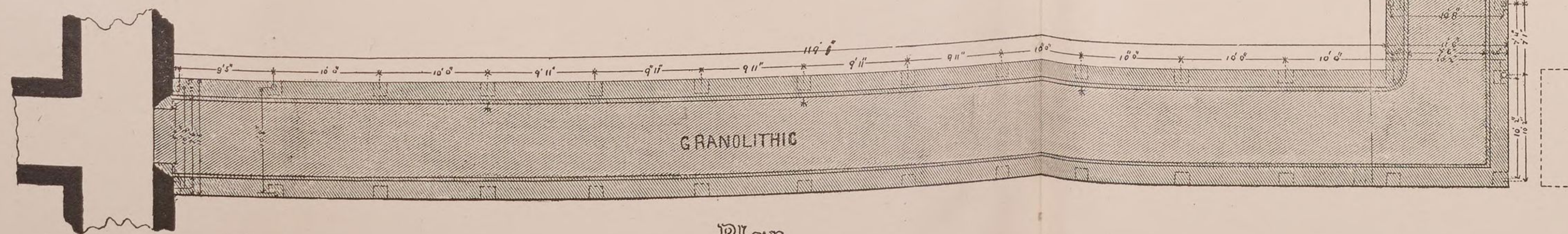
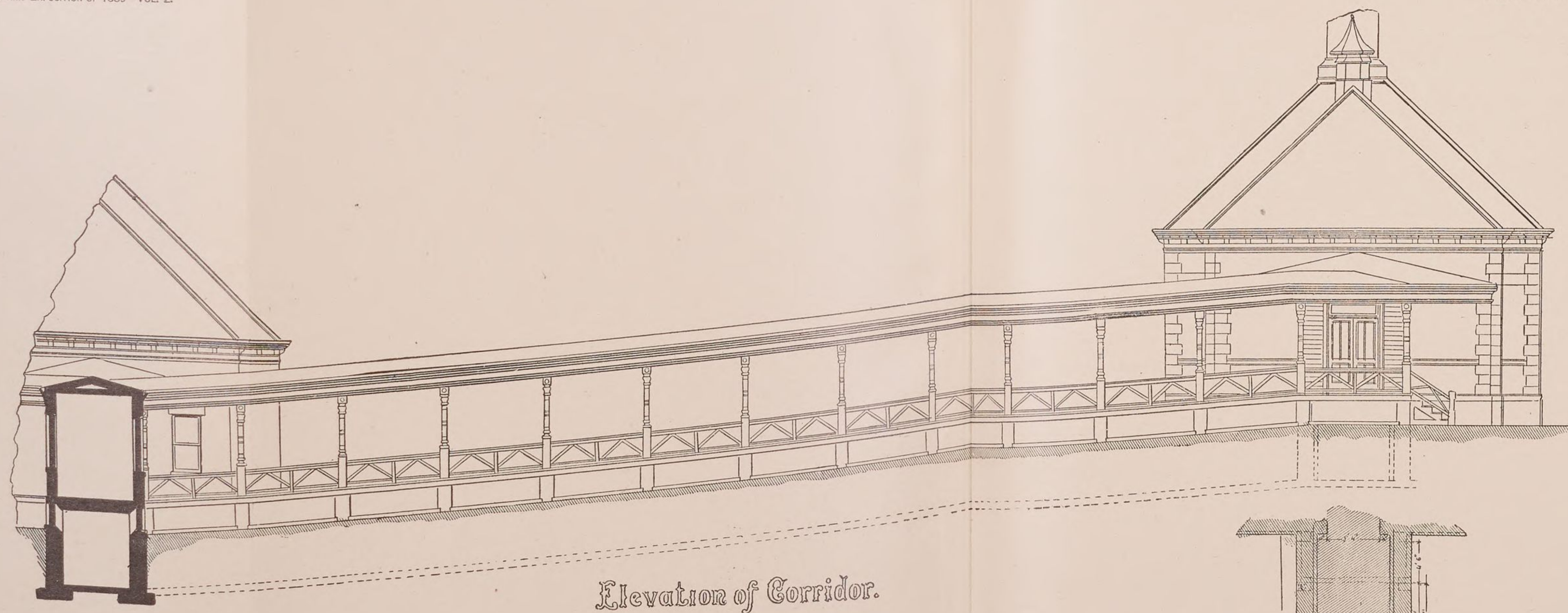
Longitudinal Section.

ST. LUKE'S HOSPITAL—CHILDREN'S PAVILION.

PLATE CXL.

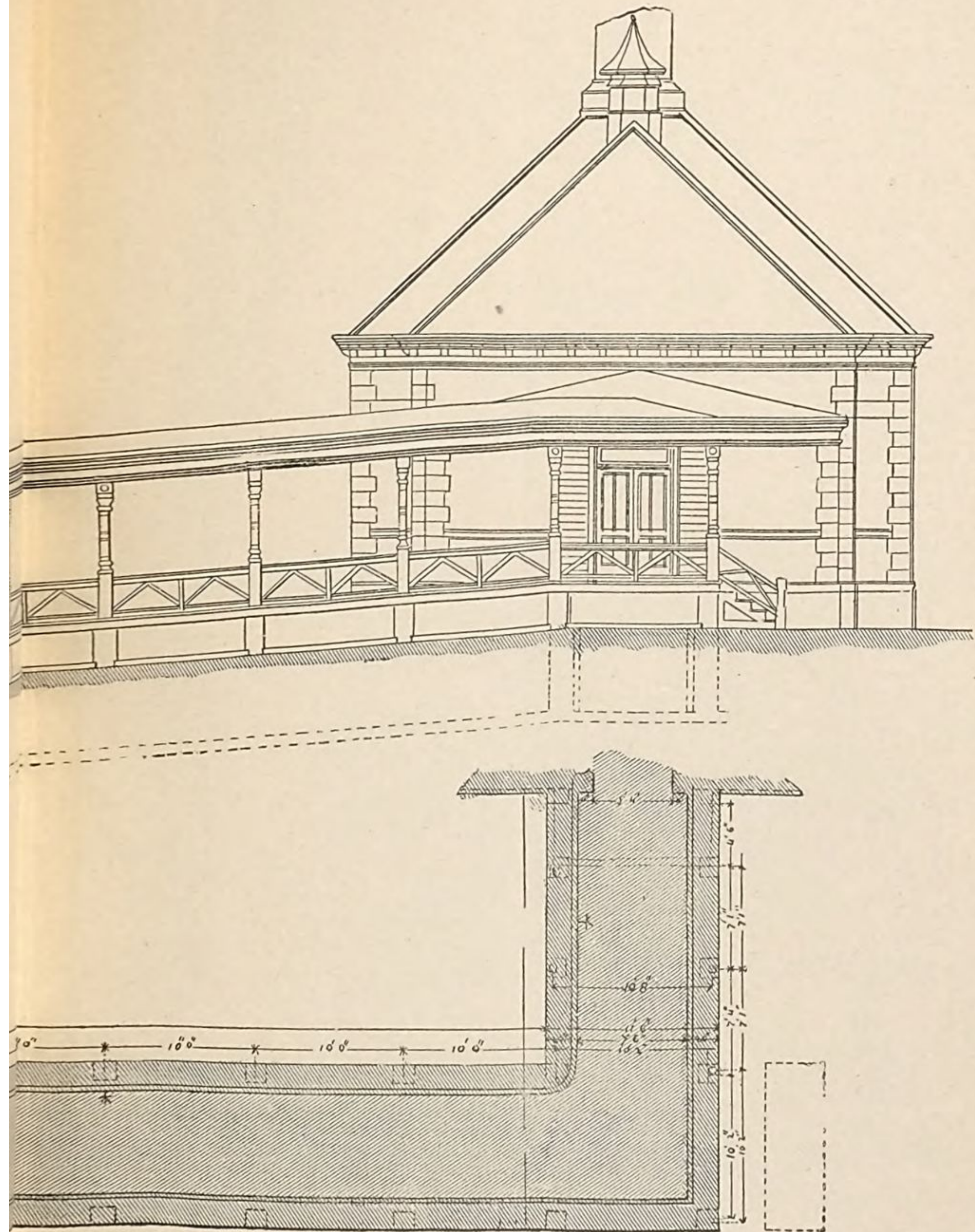


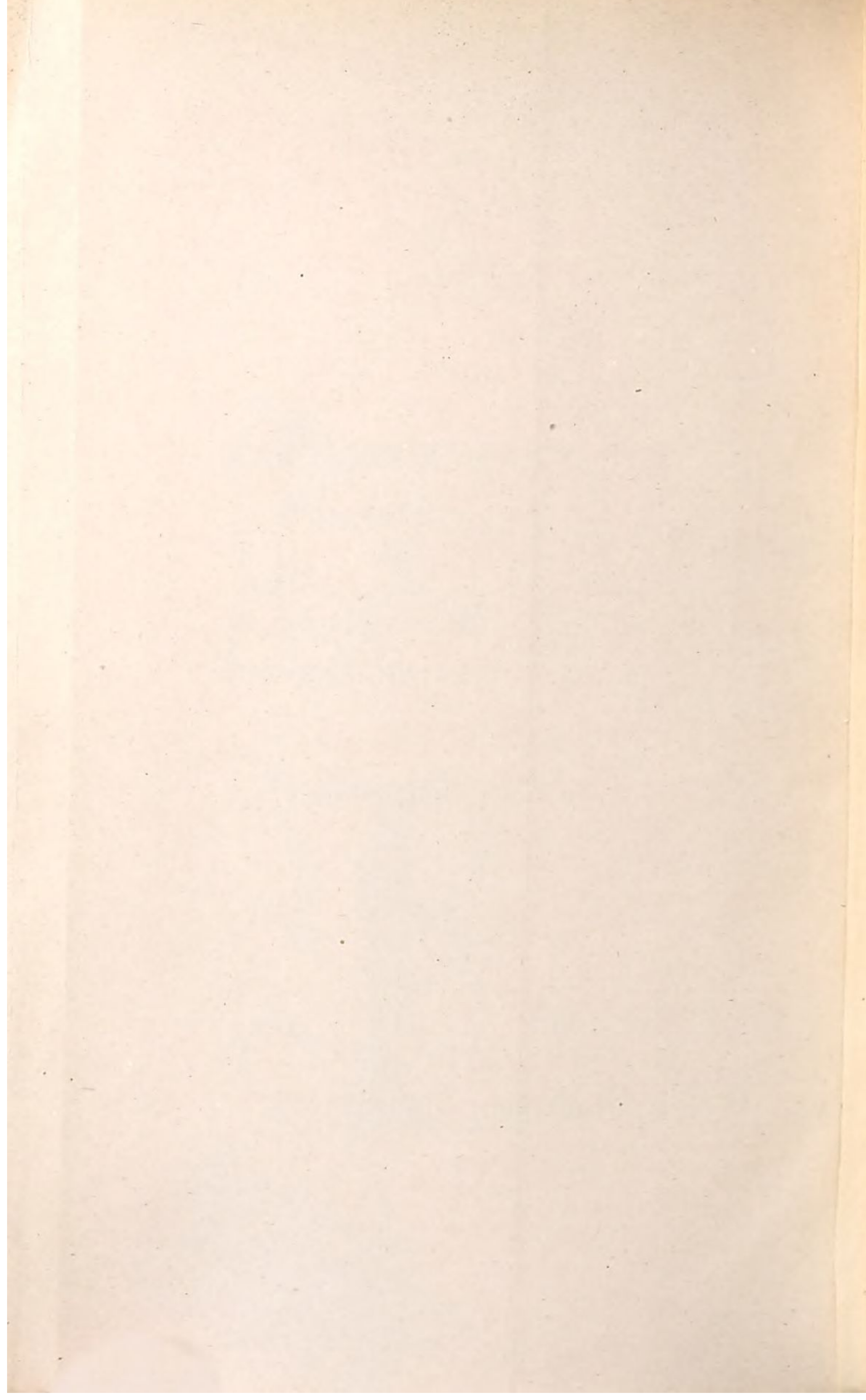




ST. LUKE'S HOSPITAL—CHILDREN'S PAVILION.

PLATE CXLI.





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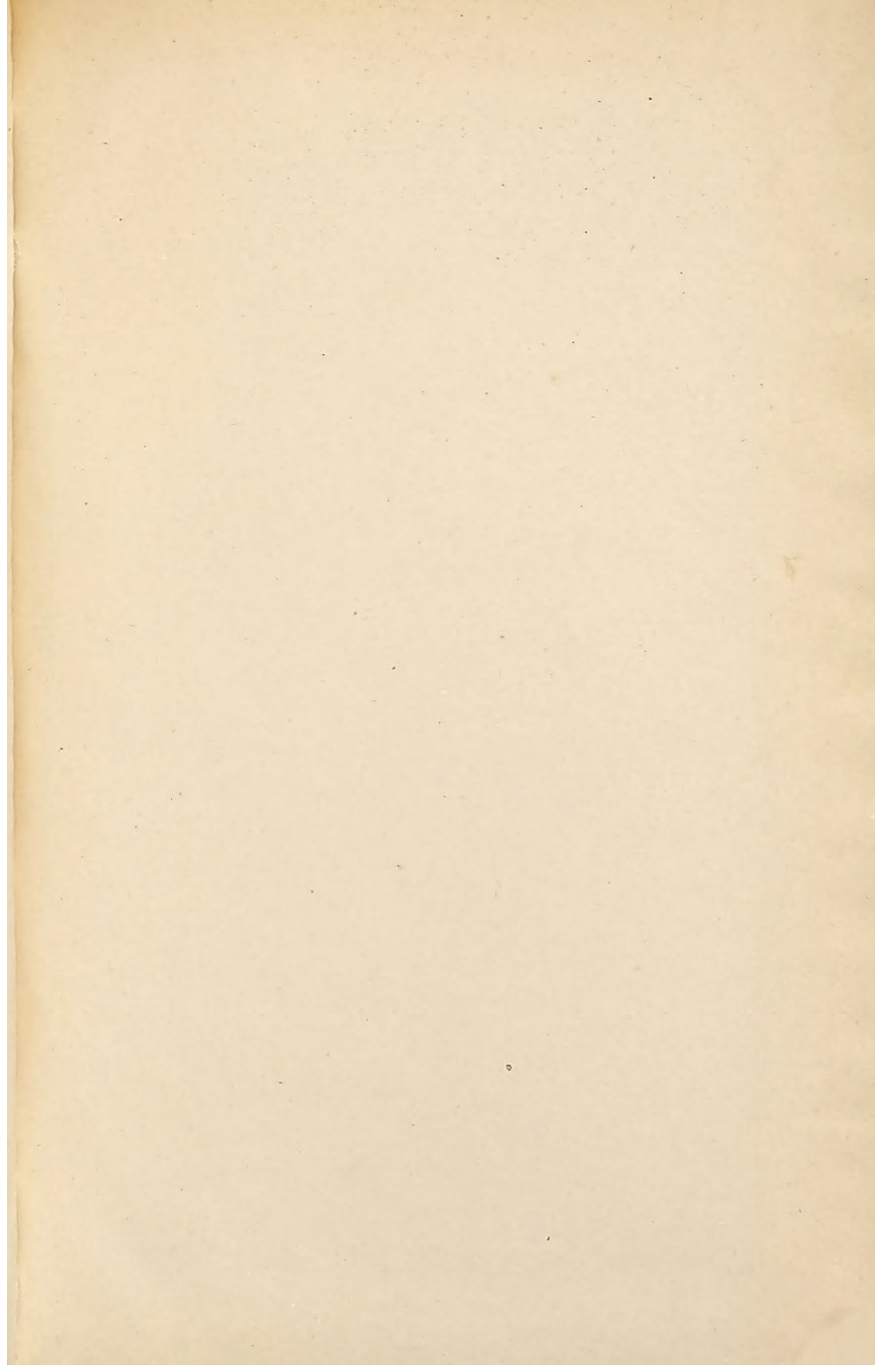
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